A PROSPECTIVE ANALYSIS OF FUNCTIONAL OUTCOME OF UNSTABLE INTERTROCHANTERIC FRACTURES MANAGED WITH PROXIMAL FEMORAL NAIL

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ORTHOPAEDIC SURGERY

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MEDICAL COLLEGE, SALEM

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CERTIFICATE

This is to certify that **Dr. K.VANANGAMUDI**, Postgraduate student (2010-2013) in the department of Orthopaedics, Government Mohan Kumaramangalam Medical College, Salem has done this dissertation "**A PROSPECTIVE ANALYSIS OF FUNCTIONAL OUTCOME OF UNSTABLE INTERTROCHANTERIC FRACTURE MANAGED WITH PROXIMAL FEMORAL NAIL"** under my supervision in partial fulfillment of the regulation laid down by the Tamilnadu Dr. M.G.R Medical University, Chennai for MS (Orthopaedics) degree examination to be held during April 2013.

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DECLARATION

I, **Dr. K.VANANGAMUDI**, solemnly declare that this dissertation titled "**A PROSPECTIVE ANALYSIS OF FUNCTIONAL OUTCOME OF UNSTABLE INTERTROCHANTERIC FRACTURE MANAGED WITH PROXIMAL FEMORAL NAIL**" is a bonafide work done by me, at Government Mohan Kumaramangalam Medical College, Salem between the period 2010-2013, under the guidance of my unit Chief **Prof. Dr.C.KAMALANATHAN, M.S.(ORTHO).,D.ORTHO,** Head of Department, Orthopaedic Surgery. This dissertation is submitted to Tamilnadu Dr. M.G.R Medical University, towards partial fulfillment of regulation for the award of M.S.Degree (Branch – II) in Orthopaedic Surgery.

Place : Salem - 1.

Date : **(Dr. K.VANANGAMUDI)**

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CONTENTS

INTRODUCTION

Intertrochanteric fractures are seen with increasing frequency and severity as the life expectancy of our population increases[33]. Intertrochanteric fractures usually occur in older patients with decreased bone strength and density. Rapid mobilization of these elderly patients reduces the morbidity and mortality rate. Historically, non operative management has resulted in excess rates of medical morbidity and mortality, as well as malunion and nonunion. Non operative management is appropriate only in selected non ambulators who experience minimal discomfort from injury.

Being most common among elderly individuals, nowadays these fractures are also commonly seen in younger age group[2] resulting from high energy trauma and often are associated with other fractures.

Cummings et al.[1,31] attributed four factors in determining whether a fall in elderly is significant to cause fracture,

1. The fall must be oriented such away that the person lands on or near the hip.
2. The protective reflexes must be inadequate to reduce the energy of fall below the critical threshold

3. Muscles and fat acting as local shock absorbers around the hip must be insufficient.
4. The bone density at the hip must be inadequate to withstand the fall.

Prophylactic interventions to decrease the risk of falls and aggressive screening and treatment of osteoporotic patients[32] with high risk of fragility fracture are very important. Early postoperative rehabilitation care is more crucial. The overall aim in the management of hip fractures is to bring the patient to pre morbid functional status.

Before the introduction of suitable fixation devices, treatment of intertrochanteric fracture was non operative[7], consisting of prolonged bed rest in traction until fracture union (10 – 12 weeks). This is followed by a lengthy programme of walking training. In elderly people, this was associated with high complication rates[1]. These complications include decubitus ulcers, urinary tract infection, joint contractures, pneumonia and thromboembolic complications, resulting in a high mortality rate. In addition, fracture healing was generally accompanied by varus deformity and shortening because of the inability of traction to effectively counteract the deforming muscular forces. For these reasons, the treatment of intertrochanteric fracture by reduction and internal fixation has become the standard method of treatment.

The commonly available methods of internal fixation are Dynamic hip screw and proximal femoral nail. The Proximal femoral nail[3] by its favourable biomechanical properties offers better mechanical stability, early weight bearing, more suitable for unstable fractures and osteoporotic elderly individual.

AIM OF THE STUDY

The aim of the study is to prospectively analyse the functional outcome of unstable intertrochanteric fractures managed with ‘PROXIMAL FEMORAL NAIL’ at Government Mohan Kumaramangalam medical college hospital, Salem between May 2010 to September 2012.

ANATOMY

The upper end of femur[4] includes the head, neck, greater trochanter, lesser trochanter, intertrochanteric line and intertrochanteric crest.

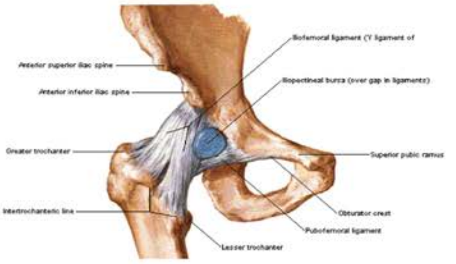
The femur is the second long bone in the body to start ossifying. The primary center appears in the shaft during 7th fetal week. Four secondary centers, one for lower end appears at the end of ninth month of intrauterine life, one for head appears during first six months of life and fuses at around 16yrs , one for greater trochanter appears during fourth year and fuses at around 14yrs, one for lesser trochanter appears during 12 yrs and fuses at around 13yrs.

HEAD

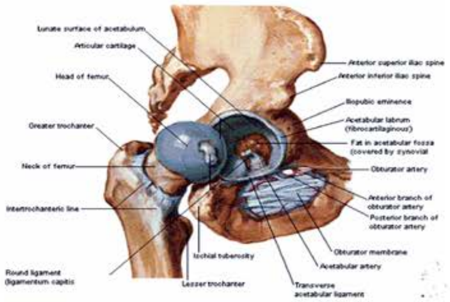
It forms more than half of a sphere and is directed medially, upwards and slightly forward. It articulates with the acetabulum to form the hip joint. The roughened pit, situated just below and behind its centre is called the fovea. It provides attachment to the ligament of head of femur (the round ligament or ligamentum teres).

ANATOMY OF HIP JOINT

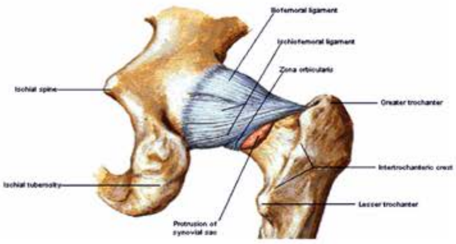
Hip Joint
Anterior View



Hip Joint [Opened]
Lateral View



Hip Joint
Posterior View



NECK[5]

It is about 5cm long and forms an angle of about 125° to 140° (neckshaft angle)[1] with the shaft of femur. This facilitates movements at the hip and enable the lower limb to swing clear of the pelvis. The anterior aspect of the neck is flattened and its junction with the shaft is a prominent ridge known as intertrochanteric line. The posterior surface is convex backwards and its transverse axis is marked by intertrochanteric crest at its junction with the shaft. The anterior surface of the neck is intracapsular and on this surface the capsular ligament extends laterally to the intertrochanteric line. On the posterior surface the capsule does not reach the intertrochanteric crest. Just more than the medial half of the neck lies within the capsule. The neck does not lie in the same plane as the shaft, but is carried forwards as it passes upwards and medially. The longitudinal axis of the neck of femur makes an angle with a line drawn through the centre of two femoral condyles. The angle of anteversion is 10° - 15°.

GREATER TROCHANTER

It is the traction apophysis, which is large quadrangular prominence at the upper part of junction of the neck with shaft. The upper border of it lies at the level of centre of head. It provides insertion of gluteus medius, minimus and maximus, obturator internus, two obturator externus and pyriformis. The tip of the greater trochanter is the entry point for proximal femoral nail.

- Gluteus minimus : Inserted into the rough impression on the anterior surface
- Gluteus medius : Inserted into the oblique strip which runs downwards and forwards across its lateral surface.
- Pyriformis : Inserted into the upper border of trochanter.
- Obturator internus, Gamellis superior and inferior : inserted by a common tendon into the medial surface of upper border of trochanter.
- Obturator externus : Inserted into the trochanteric fossa.

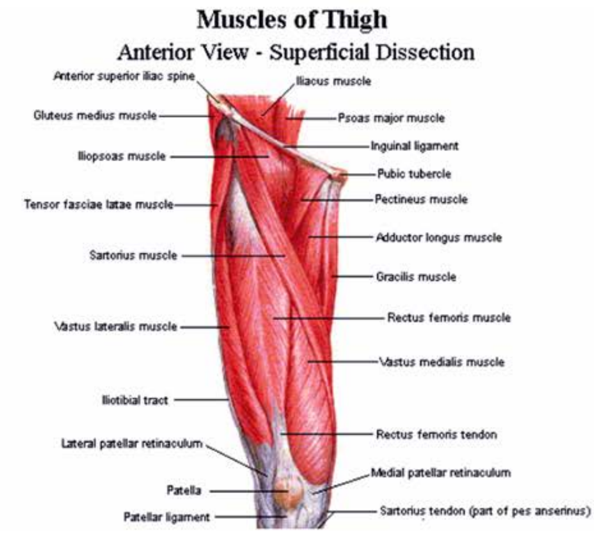
PYRIFORMIS FOSSA

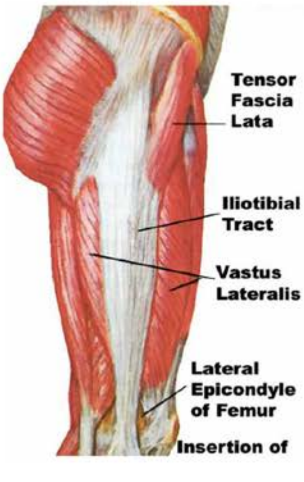
It is situated just medial to the greater trochanter. It is the entry point for most 1st generation nail.

LESSER TROCHANTER

It is a conical eminence directed medially backward from the junction of postero-inferior part of neck with the shaft. From the apex 3 borders extend;

ANATOMY OF THIGH





Two of these are above,

1. Medial border continuous with the lower border of the neck.
2. Lateral with the intertrochanteric crest.
3. Inferior border is continuous with the middle division of the linea aspera.

Psoas major: Inserted on the summit of lesser trochanter

Illiacus : Inserted at the base of lesser trochanter.

INTERTROCHANTERIC LINE:

It marks the junction of anterior surface of the neck with shaft of femur. It begins above at the anterosuperior angle of the greater trochanter and is continuous below with the spiral line in front of the lesser trochanter. It provides attachment to the,

- Capsular ligament of the hip joint.
- Upper band of illiofemoral ligament in the upper part.
- Lower band of iliofemoral ligament in lower part; origin to the highest fibres of the vastus lateralis from the upper end and the origin to the highest fibres of vastus medialis from the lower end of the line.

INTERTROCHANTERIC CREST:

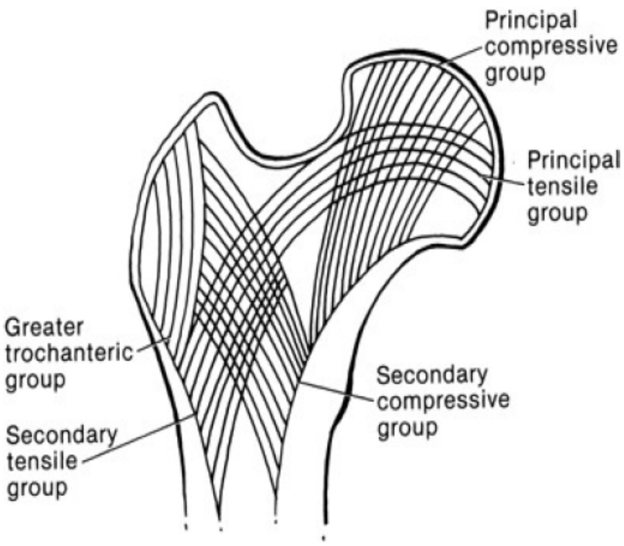
This marks the junction of posterior part of neck with shaft of femur. It begins above at the posterosuperior angle of greater trochanter and ends at the lesser trochanter. The rounded elevation, a little above its middle is called the quadrate tubercle, which provides insertion to quadratusfemoris extending to the area below it.

TRABECULAR PATTERN

Ward[6] first described the internal trabecular structure of proximal femur in 1838. According to the wolf's law, trabeculae are oriented along the line of stress and thicker lines come from the calcar and raise superiorly into the weight bearing dome of the femoral head. Upper end of femur is composed of cancellous bone which shows two different types of trabeculae, namely the compression and tensile group.

The trabeculae[6] have been divided into following five groups:

1. Primary compressive
2. Secondary compressive
3. Greater trochanteric
4. Primary tensile
5. Secondary tensile



Ward’s triangle is bounded by primary compressive, secondary compressive and primary tensile group.

Harty and Griffin[6] described the calcar femorale a dense vertical plate of bone extending from the posteromedial portion of the femoral shaft under the lesser trochanter and radiating lateral to the greater trochanter, reinforcing the femoral neck posteroinferiorly. Calcar femorale is a vertical plate of bone that extends from the posteromedial cortex of femur deep to the lesser trochanterand blends with the posterior cortex of the femoral neck. The calcar femorale is thickest medially and gradually thins as it passes laterally.

MOVEMENTS OF THE HIP JOINT AND THE MUSCLES PRODUCING THE MOVEMENTS

1. **Flexion** : It ranges from (0 - 90°) with extension of knee and (0 – 130°)with flexion of knee. Psoas major and the illiacus are the major contributors and minor contribution is by rectus femoris, Sartorius, pectineus and adductor longus in the early flexion from full extension.
2. **Extension** (0 to 15°): Gluteus maximus and hamstrings are active when the thigh is extended against resistance.
3. **Abduction** (0 – 45°): Gluteus minimus and gluteus medius are the major contributors. Sartorius, tensor fascia lata and piriformis are the minor contributors.
4. **Adduction** (0 – 40°) : Adductor fibres of adductor magnus, adductor longus and adductor brevis are the main adductors. Pectineus and gracilis are the minor adductors.
5. **Medial rotation** (0 – 30°) : Anterior fibres of Gluteus medius, gluteus minimus and tensor fascia lata are the major contributors. Minor contribution by the adductors.
6. **Lateral rotation** (0 – 40°) : Quadratus femoris, obturator internus, obturator externus, superior and inferior gamelli are the major

contributors. Minor contribution by the gluteus maximus, Sartorius, piriformis.

7. **<u>Circumduction</u>** : It is the combination of other movements.

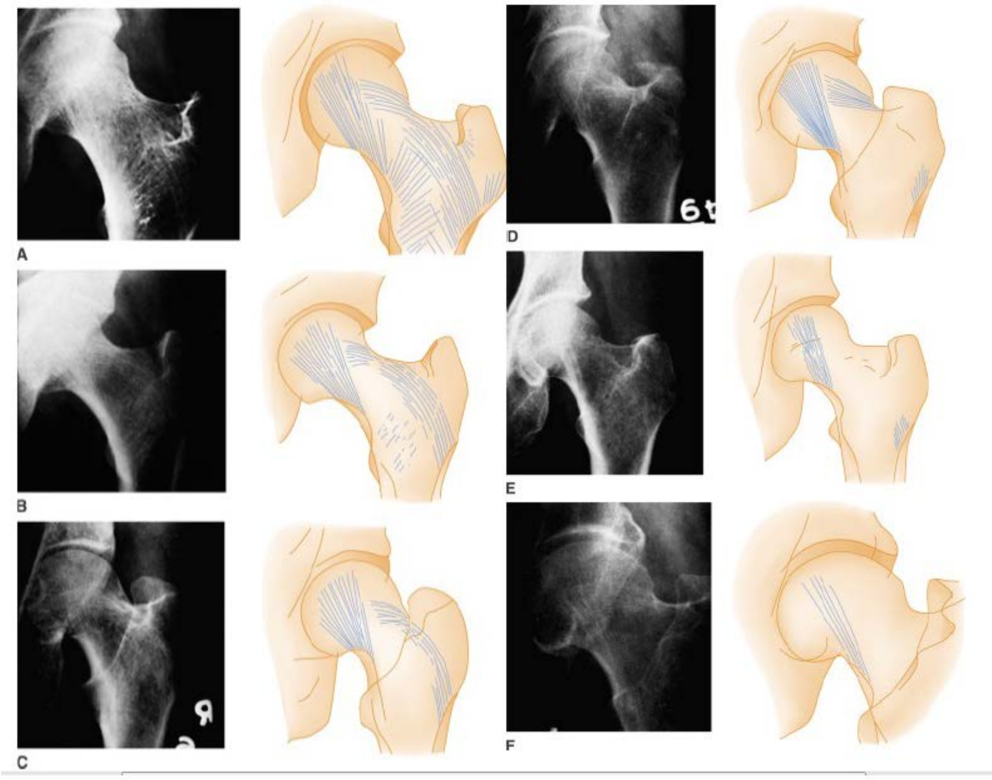
SINGH'S INDEX FOR OSTEOPOROSIS[6,30]:

This is used to grade osteopenia based on the reduction in trochanteric, tensile and primary compressive trabeculae. The grade is determined from the anteroposterior projection of an intact proximal femur. There are totally 6 grades[30], graded from 1 to 6.

Normal – grade 6 : all trabecular groups are visible

Definite - grade 3 : thinned trabeculae with a break in the principal tensile group

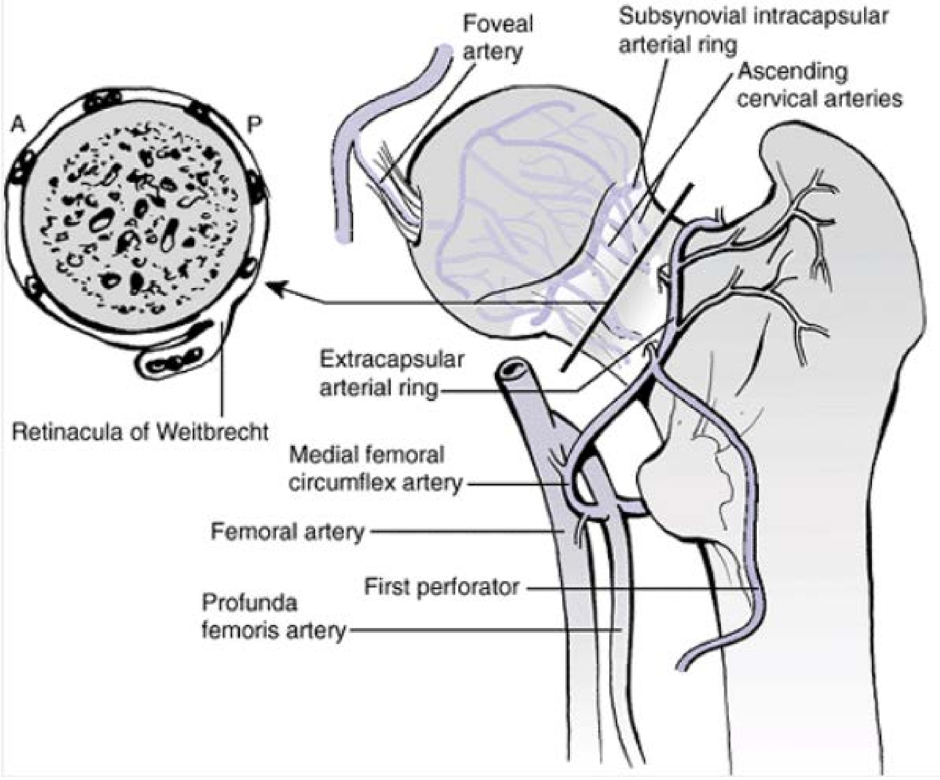
Severe – grade 1 : only the primary compressive trabeculae are visible and they are reduced

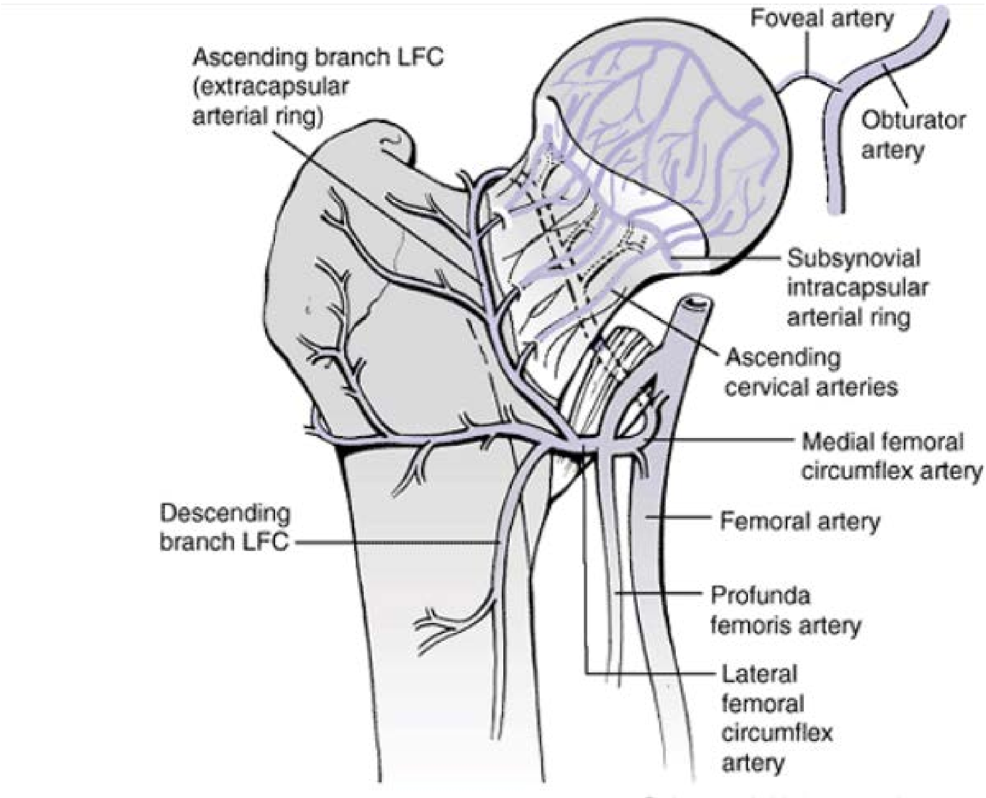


BLOOD SUPPLY OF THE PROXIMAL FEMUR[1,9,10]

An extracapsular arterial ring is formed anteriorly by ascending branch of lateral femoral circumflex artery and posteriorly by medial circumflex femoral artery. The ascending cervical branch from this ring pierce the hip capsule near its distal insertion, becoming the retinacular arteries supply the femoral head. A subsynovial intracapsular arterial ring enter the femoral head and unite to form the lateral epiphysial arteries. These lateral epiphyseal arteries supply the majority of femoral head. The artery of ligamentum teres , a branch of obturator artery supply a small portion of femoral head around the fovea capitis.

BLOOD SUPPLY OF THE PROXIMAL FEMUR





The femur has very rich blood supply. Like most long bones, it can derive blood from periosteal vessels, but normally the major source is a single nutrient artery, which arises from first or second branch of profunda femoris artery. This nutrient vessel enters the bone near the medial side of linea aspera. Once inside the bone the vessel arborise proximally and distally to form circulation of shaft. Similarly, the small periosteal vessels that enter the femur do along the linea aspera. These small periosteal vessels supply the outer one third to one fourth of the cortical bone, whereas the endosteal vessels supply the inner part. Inside the cortex, there is direct communication between these two vessels. The normal blood flow is centrifugal, although some blood returns to the large venous sinusoids of the medullary canal.

The medial circumflex artery is the major arterial supply. It passes around the femur proximal to the lesser trochanter gives off two or three branches to lesser trochanter. Its branches also supplies to the posterior surface of the base of the neck and as it passes more laterally it gives off two or three branches into the upper surface of the neck near its junction with greater trochanter.

BIOMECHANICS OF HIP JOINT[8,10,12,34]

The forces acting on the hip joint may be static or dynamic. Static force means application of external loads or forces in such a way that they are balanced out each other and the joint is not subjected to acceleration. Dynamic forces on the other hand refer to unbalanced loads or forces associated with acceleration or deceleration. The forces include both gravity as well as forces generated by muscle activity.

The forces acting on the hip joint result from stabilizing the body's centre of gravity during stance and locomotion. The centre of gravity of the body is located just anterior to the second sacral vertebra. The horizontal distance from the centre of gravity of the body to the centre of hip joint is 8.5 to 10 cm. vertically the centre of gravity is about 3cm above the hip joint axis and during stance the centre of gravity is the same frontal plane as the common hip joint axis. The force acting on the hip joint is the sum of the supported body weight and tension developed in the abductors. The forces acting on the hip joint are normally quite large and much more than body weight. Loss of one pound of body weight relieves three pounds of pressure. A long femoral neck is an advantage to hip motion. The ratio of the two lever arms is important in the generation of total force acting on the hip joint. The shorter the horizontal distance from the centre of gravity of the body to the hip joint, less muscle force is required of abductors to balance it. Medial displacement of femoral head upon the pelvis may cause a greater decrease in joint pressure. If the individual leans the trunk directly over the weight bearing hip, the medial lever arm is reduced to zero so that no muscle force is necessary in the abductor tensor muscles(as in trendelenberg's gait) joint reaction force is reduced to body weight. If the centre of gravity is moved away from the weight bearing hip abductor force is more and hence the joint reaction force is increased.

BIOMECHANICS OF TROCHANTERIC FRACTURES[8,10,12,34]

Operative treatment of intertrochanteric hip fractures with internal fixation creates a fracture fragment – implant assembly intended to withstand the forces acting on the fracture site. Since avoiding recumbency is often the goal of internal fixation and since many patients with trochanteric hip fractures lack the balance, co-ordination and ability to avoid weight bearing upon the fractured femur, it is often necessary that the fracture fragment implant assembly be strong enough to withstand the body weight and the very considerable muscle forces which act on the trochanteric region of femur. These forces have been shown to be equivalent to as much as three times the body weight acting upon the femoral head**.**

Creating a fracture fragment implant assembly capable of withstanding loads of this magnitude is the bio mechanical goal of the surgeon who elects upon the operative treatments of intertrochanteric fractures. Its strength depends on, (Kaufer et al[47])

1. Bone quality
2. Fragment geometry
3. Reduction
4. Implant
5. Implant placement.

BONE QUALITY:

The mechanical properties of bone (hardness, elasticity, strength, etc) vary considerably depending upon age, sex, race, general state of health, muscle mass, and level of activity. Bone strength varies in different bones in same individual as well as in different areas in the same bone. Most of the unstable intertrochanteric fractures are relatively low trauma injuries occurring in osteoporotic bones.

FRAGMENT GEOMETRY:

Much clinical attention is focussed upon the number, size, location and displacement of trochanteric fracture fragment. Comminution, especially if it involves the posterior and medial portion of the trochanteric region is recognized as a major factor contributing to the complications of fixation. Multiple fragment fracture with comminution extending into the medial and posterior femoral cortex is far more likely to displace into varus and retroversion. Fractures with posterior and medial cortical comminution are therefore considered unstable, while two parts trochanteric fractures are far more likely to be stable. Although reduction and inter fragmentary fixation of the lesser fragment of a comminuted unstable intertrochanteric fractures can contribute to the stability of the post fixation assembly, in practice, interfragmentary fixation is time consuming, frequently disappointing and may contribute to infection and other biological complications of operative treatment. It is therefore generally agreed that one should ignore the lesser fragments and concentrate on gaining stable fixation of the major proximal fragment to the major distal fragment attaining posteromedial cortical contact.

REDUCTION:

An unstable reduction is one in which there is insufficient contact between the fragment to contribute to the post reduction integrity of the proximal femur. Post fixation strength of an unstable fracture reduction depends entirely upon the mechanical characteristics of the implant. Stable reduction of a unstable intertrochanteric fracture gives sufficient postero medial cortical contact between the major proximal fracture fragment and the major distal fragment to resist the varus and the posterior distilling forces which predominate in these fracture. Stable reduction contributes significantly to the strength of the post fixation assembly. Restoration of normal anatomy is the goal of all fracture treatment. Cadaveric studies of unstable intertrochanteric fractures stabilized with anatomic reduction, showed optimal stress distribution (highest compression strain in the medial cortex and lowest strain on the side plate).

Reduction and fixation of the posteromedial fragment depends on the size of the fragment. Anatomic reduction of a large posteromedial fragment increase the load resistance by 57 % whereas fixation of a small posteromedial fragment increase the stability only by 17%. (Apel et al).However, anatomic reduction of unstable intertrochanteric fracture can be difficult to achieve and is associated with a prohibitive frequency of complication of fixation. Recognition of this problem has stimulated recent interest in non – anatomical stable reduction. Of these, the medial displacement reduction advocated by Dimon and Hughston was most popular. There is however no evidence to suggest that medial displacement is mechanically superior to a perfect anatomic reduction. Non anatomical reduction should therefore be reserved for those fractures in which perfect anatomic reduction cannot be achieved. Valgus reduction markedly decreases joint reaction force moment arm. However, severe degrees valgus should be avoided because it demands increased abductor muscle power to stabilize the pelvis during single leg stance and increase the joint reaction force. Valgus reduction may therefore contribute to an abductor limp or post traumatic arthritis.

IMPLANTS:

Sliding hip screw includes traditional compression hip screw that provides compression in the intertrochanteric plane and compression plate that provide axial compression in addition.

Sliding hip screws are available with plate angles from 125° to 150 °. Even though the 150 ° are preferable because the angle of the lag screw more closely parallel with the compression forces within the femoral neck and hence less chances of failure of implant due to bending force, in clinical studies there is no difference in the compression ability between 135° hip compression screws and 150° devices.

Considering the problem of insertion of 150 ° devices into the center of the femoral head with more distal entry point below the lesser trochanter, the higher angled plates are only indicated for extremely valgus femoral neck fractures and more distal fractures. Moreover, 135° devices are can be easily applied and their clinical results are comparable with those for the 150 ° plates. Hence 135 ° devices are more frequently used. Depending upon the length of the measured sliding hip screw, either short or long barreled plate devices are used. Long barreled plates are used when the length of the measured sliding hip screw is more than 85 mm.

NAIL PLACEMENT:

Optimal implant placement is determined by the distribution of good bone within the proximal fragment as well as the net sum of force vectors acting upon it. Telescoping implants are least likely to penetrate into the joint and may therefore be inserted more deeply into the proximal fragment, thus affording maximal proximal fragment control. The center of pressure acting upon the femoral head lies within the head's antero-superior quadrant. It is therefore best to place the fixation device in the postero-inferior quadrant of the head of the femur so that the device must plough through the maximal quality of bone before it cuts out.

Depth of screw insertion is always a compromise. Based upon a consensus of laboratory and clinical data, the ideal position of screw must be within 10 mm. from the subchondral cortex and in the postero-inferior quadrant of the head of the femur. This position places the tip of the implant into bone formed by the decussation of the tension and compression trabaculae, thus assuming maximal proximal fragment control. One of the major advantages of a telescoping device with a blunt end is the ability to insert it close to the subchondral cortex of the femoral head with minimal risk of joint penetration within the limits of technical skill, implant placement is the surgeon's choice.

Of the 5 determinants of trochanteric fracture fixation, though the bone quality and fragment geometry are of great importance, they are non modifiable by the surgeon. The surgeon's role is important in fracture reduction, implant selection and its placement.

SIGNS AND SYMPTOMS

On examination, the attitude of the affected limb will be in classical external rotation with shortening >2cm and lateral border of the foot touches the bed completely. There may be swelling around the hip and proximal end of thigh depending upon the severity of trauma. Acute tenderness may be elicited over the trochanteric region. Patient is unable to do straight leg raising. There will be abnormal mobility at the fracture site. There may be presence of ecchymosis at the lateral aspect of proximal thigh.

PRE OPERATIVE RADIOLOGICAL EVALUATION[1]

The following x- rays are taken,

1. X ray pelvis with both hip anteroposterior view
2. Anteroposterior view of the involved proximal femur.
3. Cross - table lateral view of the affected hip.
4. AP and lateral view of the involved femur with knee joint.

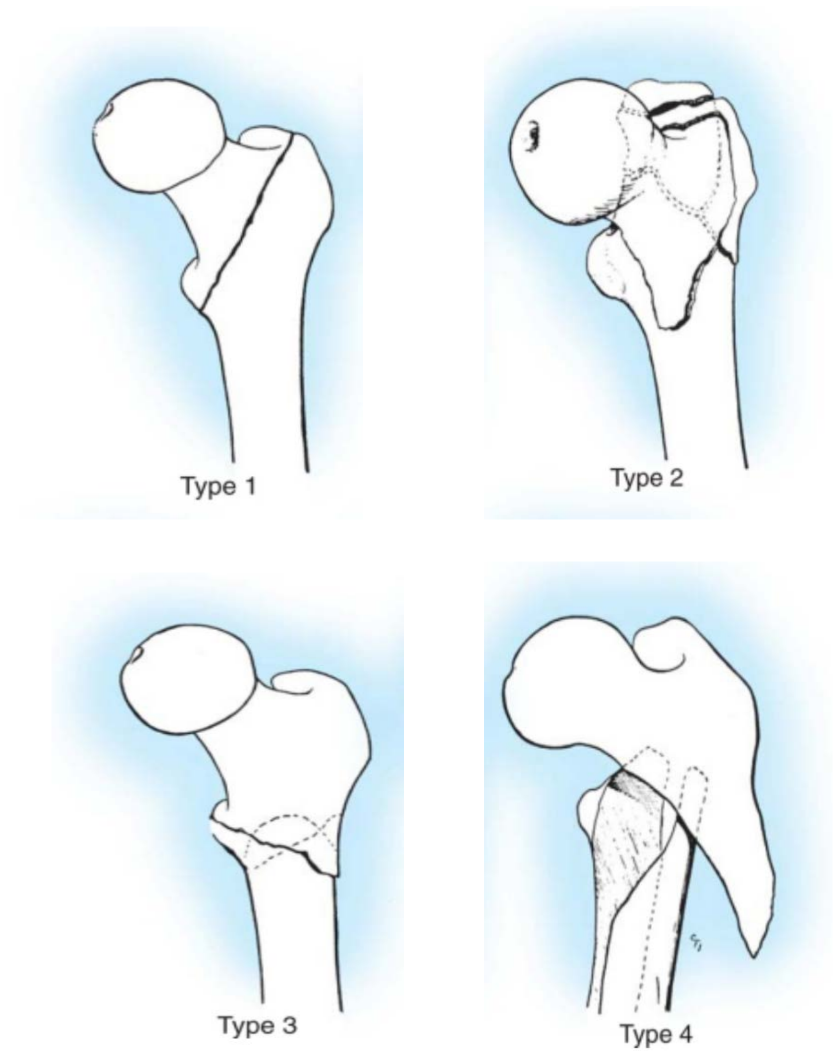
In situations where the fracture geometry is not clear due to deformity, an AP view of the hip internally rotated 15 ° to 20 ° may be helpful. Moreover it eliminates the normal anteversion and gives a true anteroposterior picture of the proximal femur. AP view of the contralateral side is helpful, particularly as a means of assessing the size and angle of the implant for intramedullary fixation.

The lateral x-ray is useful to assess the posteromedial cortex for signs of comminution. Frog lateral view taken with the hip flexed, abducted and externally rotated may cause displacement at the fracture site. So cross-table lateral view is preferred to a frog lateral view. AP and lateral view of the involved femur with knee joint is useful to identify the amount of femoral bow.

Technetium bone scan and magnetic resonance imaging (MRI) scan may be taken when the hip fracture is difficult to make out in routine x – rays. Though the sensitivity of MRI in detecting the occult fracture is similar to that of bone scan, it can reveal a fracture within first 24 hours. 3D CT is more helpful in assessing the fracture pattern.

CLASSIFICATION

BOYD & GRIFFIN CLASSIFICATION (1949)[13,14,15] includes fractures from the extracapsular part of the neck to a point 5 cm distal to the lesser trochanter.



TYPE 1: Fractures that extend along the intertrochanteric line from the greater to the lesser trochanter. Reduction usually is simple and is maintained with little difficulty.

TYPE 2: Comminuted fractures, the main fracture being along the intertrochanteric line, but with multiple fractures in the cortex. There may be additional fracture in the coronal plane, which can be seen on the lateral radiograph.

TYPE 3: Fractures that are basically subtrochanteric with at least one fracture passing across the proximal end of the shaft just distal to or at the lesser trochanter. Varying degrees of comminution are associated..

TYPE 4: Fractures of the trochanteric region and the proximal shaft, with fracture in at least two planes.

EVANS CLASSIFICATION (1949)[14,15,48] based on the division of fractures into stable and unstable groups. He divided unstable fractures further into those in which the posteromedial cortex could be restored by anatomical or near-anatomical reduction and those in which anatomical reduction would not create stability.

Type I:

The fracture line extends upward and outward from the lesser trochanter.

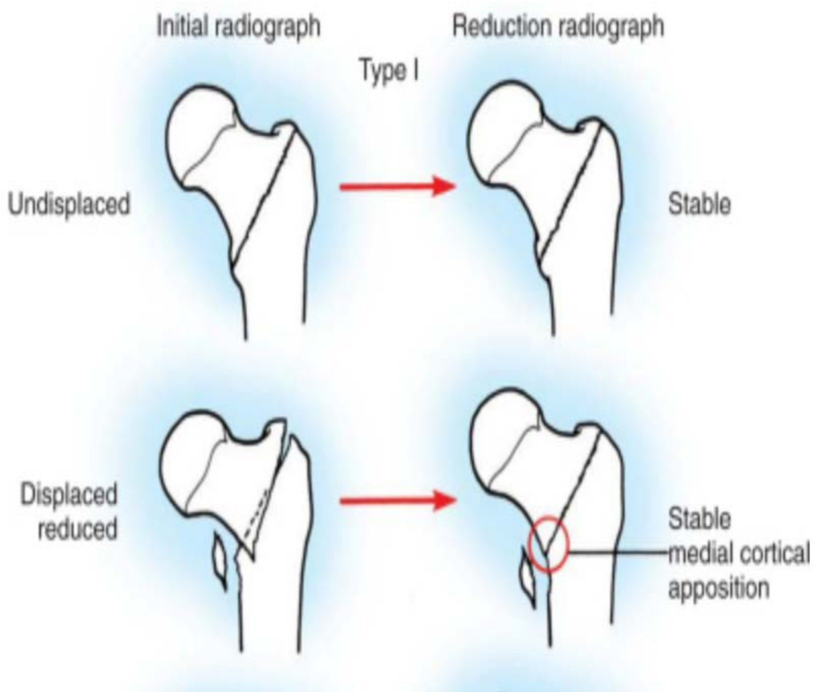
Stable:

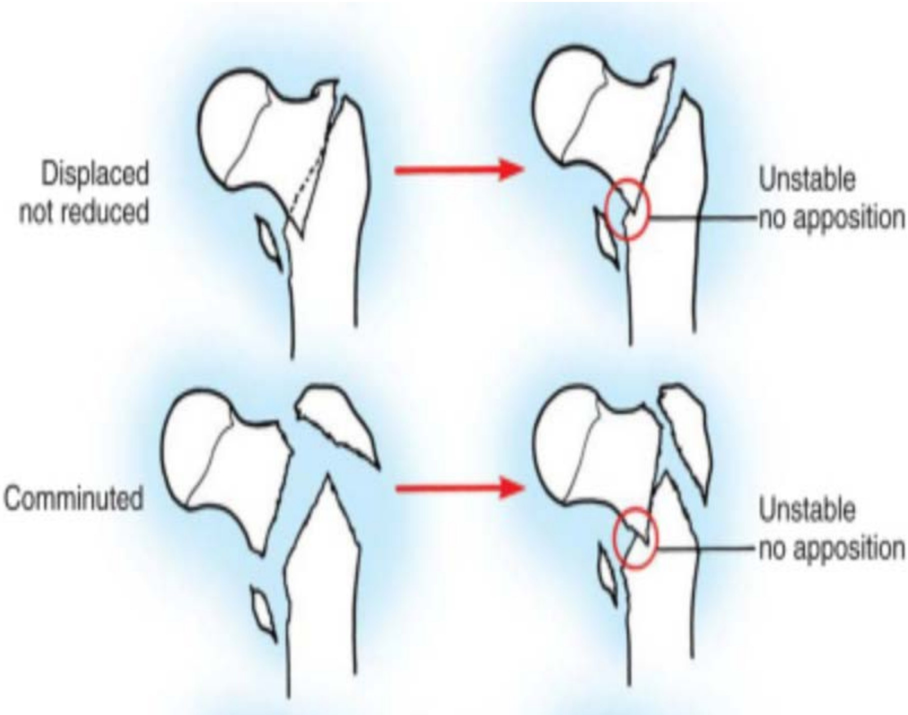
-Undisplaced fractures.

-Displaced but after reduction overlap of the medial cortical buttress make the fracture stable.

Unstable:

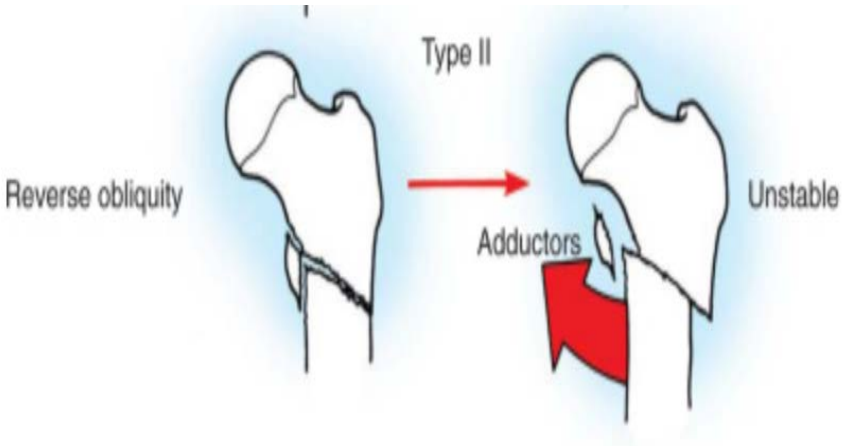
-Displaced and the medial cortical buttress is not restored by reduction of fracture.





Type II:

Reverse obliquity fractures. The major fracture line extends outward and downward from the lesser trochanter. Type II fractures have a tendency toward medial displacement of the femoral shaft because of the pull of the adductor muscles.



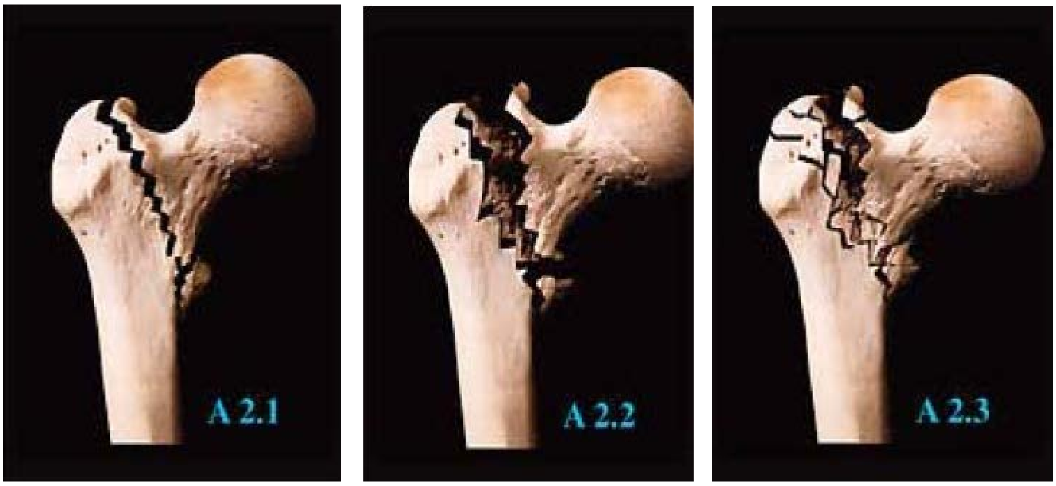
AO CLASSIFICATION[1,6,13,17]

AO group has classified the trochanteric fractures into stable and unstable types. The stable trochanteric fractures have an intact medial buttress comprising 70% of the cases. The unstable problematic types have large posterior fragment in addition to the medial fragment. They emphasize that for stability, the medial and posterior cortex should be intact. In treatment of unstable trochanteric fractures medial buttress should be reconstructed before fixation with an implant.

Type 31A1 is considered to be stable fractures and Type 31A2 and 31A3 are considered to be unstable trochanteric fractures.

Type 31A1

Type 31A2



Type 31A3

Type 31A1

They are simple pertrochanteric fractures. In these the fracture line can begin anywhere on the greater trochanter and end either above or below the lesser trochanter. There are only two fragments, and the medial cortex is interrupted in only one place. The important feature is that these are stable after reduction and fixation, largely because of the excellent contact of the fracture surfaces and no bone loss. The lesser trochanter, the so-called medial buttress, is intact.

Type 31A2

Multifragmentary pertrochanteric fractures. The fracture line can start laterally anywhere on the greater trochanter and runs towards the medial cortex which is broken in two different places. This results in the detachment of a third fragment which includes the lesser trochanter.

A2.1 fractures may be considered stable after anatomical reduction because the lesser trochanteric fragment is small, and the greater trochanter is intact.

A2.2 and A2.3 fractures are multifragmentary and unstable after reduction. The greater trochanter is involved and fractured and often displaced. The exact fracture pattern is often difficult to determine on emergency x-rays.The posteromedial loss of bone combined with certain fracture patterns makes these fractures unstable and difficult to treat. There is an ongoing discussion as to which is the best implant for their fixation. Generally the less stable the fracture, the greater the indication for intramedullary fixation.

Type 31A3

These are true intertrochanteric fractures. They are classified according to the fracture pattern. The fracture line passes between the two trochanters, above the lesser trochanter medially and below the crest of the vastus lateralis laterally. Both femoral cortices are involved.

A3.1 fractures, the so-called reverse oblique, often have a typical displacement because of the pull of the abductors which abduct and flex the proximal fragment. Be careful in determining the distal extension of the fracture line as fissures far down into the femoral shaft are not uncommon.

A3.2 fractures are transverse and most often (intertrochanteric) two-part fracture.

STABLE INTERTROCHANTERIC FRACTURES[15]:

1. The fracture runs from the greater trochanter obliquely downwards and medially to exit just above the lesser trochanter. A good portion of the calcar is attached to the proximal fragment anteromedially. Quite commonly there is an avulsion fracture of the lesser trochanter. As a rule the distal fragment is in external rotation. Rarely, the inferomedial spike of the proximal fragment is impacted into the metaphysis of proximal fragment.
2. An avulsion does not result in instability because it does not weaken the medial buttress.

UNSTABLE INTERTROCHANTERIC FRACTURES[15,35]:

- The medial fragment varies in size and reaches distally to a varying degree. As a rule it contains the lesser trochanter. If the lateral wall remains intact then the distal fragment migrates proximally because of muscle pull. Commonly there is in addition quite a large posterior fragment. Occasionally, the proximal fragment contains a long medial spike made up of calcar and lesser trochanter. This makes it into a long oblique or spiral fracture.

- If the greater trochanter is fractured then the distal fragment is not pulled upwards.
- A badly comminuted intertrochanteric fracture has in addition to the fractures of the lesser and greater trochanters further comminution posteriorly and medially[35].
- Occasionally the fracture has a reverse course[35] beginning laterally and distally and running upwards and medially. Medially it exits above the lesser trochanter. Commonly it is associated with a fracture of the greater trochanter.

TREATMENT MODALITIES

Intertrochanteric fracture can be treated both by conservative and operative methods.

TYPES OF CONSERVATIVE TREATMENT[16,17]

The various conservative methods used in patient who is unfit for surgery from medical comorbidities and non ambulatory patients who has minimal discomfort following fracture are,

1. Derotation boot.
2. Buck's extension skin traction
3. Hamilton Russell's traction
4. Modified Russell's traction
5. Skeletal traction

DEROTATION BOOT

A below knee plaster cast with a wooden bar attached to the heel to prevent external rotation. After clinical and radiological evidence of union (10 – 12 weeks), it is removed and physiotherapy was started.

BUCK'S EXTENSION SKIN TRACTION

Adhesive plaster is applied to skin below knee of the affected limb with a spreader bar and light weight.

SKELETAL TRACTION

The commonest method used in conservatively treated cases. Heavy skeletal traction is used through upper tibial sketelal pin over a Bohler Braun splint. About 10% of body weight is used for traction. Patient is advised to do quadriceps exercise every hour for 5 minutes. After 10 – 12 weeks, the traction is removed and patient is mobilized with walking aids.

HAMILTON RUSSELL'S TRACTION

Continuous traction is applied along the line of femur by traction weight applied through several pulleys. Since no splint is used patient is more comfortable. The knee is flexed over a pillow and the limb is supported while on traction. This controls both angulatory and rotational deformity.

MODIFIED RUSSELL'S TRACTION[18]

Modification used here is usage of below knee plaster cast with one pulley incorporated. The disadvantages of conservative treatment are knee joint stiffness, pin tract infection, deep vein thrombosis, hypostatic pneumonia, prolonged hospital stay, Bed sores, coxavara deformity, shortening, limitation of hip movements. The mortality and morbidity rates are very high in conservative management.

TYPES OF OPERATIVE TREATMENT[17,19,15]

The various implants available for treatment of trochanteric fractures are,

EXTRAMEDULLARY DEVICES

FIXED ANGLE NAIL PLATE DEVICES

- Thornton nail plate
- Jewett nail

SLIDING ANGLE NAIL PLATE DEVICES[20,21,22]

- Pugh sliding nail
- Massie triflanged telescoping nail

SLIDING HIP SCREW

- Richard’s compression screw
- Egger’s plate
- Medoff plate
- Alta expandable dome plunger

TROCHANTERIC STABILISATION PLATE[60]

- In addition to the DHS construct, they stabilize the greater trochanter and allows the placement of antirotational screw. Thus the prevent lateral displacement of greater trochanter as well as medialisation of the shaft during fracture collapse.

INTRAMEDULLARY DEVICES[24,25,26,27]:

CONDYLOCEPHALIC

- Ender's nail[28,30]

CEPHALLOMEDULLARY[36]

- Gamma nail[36]
- Intramedullary hip screw[29]
- Trochanteric antegrade nail (TAN)
- Proximal femoral nail (PFN)[1,17,44,45]
- Proximal femoral nail antirotation (PFNA).[1,17,46]

EXTERNAL FIXATION DEVICES:

PROSTHETIC REPLACEMENT[85]

- Leinbach's prosthesis
- Bipolar prosthesis

Gamma nail[37,38,39,40,41]	Initially Gamma nails were designed with 17 mm proximal diameter with 10 ° mediolateral angulation for entry through greater trochanter. Single lag screw of 12mm diameter with rigid screw nail assembly preventing sliding. More complications like thigh pain, femoral shaft fractures, greter trochanter blow out, screw cut out. So further modification of the nail design were introduced.
Proximal femoral nail (PFN)[42,1,44,45,]	The PFN[54,55]- length 240mm-was introduced in 1998 for the treatment of extracapsular fractures. Like the Gamma and IMHS, it consists of a nail inserted via the greater trochanter in to the medullary cavity. Two proximal lag screws are passed up the femoral neck to the head. Narrow (15mm) proximal and distal diameter to prevent trochanter fracture. Prevent stress fracture at the tip of the nail.
Proximal femoral nail antirotation (PFNA)[1,17,46,]	The PFNA [54,55]- length 170, 200 or 240 mm - is similar to the PFN nail apart from not having two proximal lag screws but instead a single helically-shaped blade. It provide rotational and angular stability. The large surface area maximizes the hold.

REVIEW OF LITERATURE

In 1564, Ambrose Pare, the great French surgeon was the first to describe the fracture at the upper end of femur.

Sir Astley Cooper (1798-1841), the English surgeon, published his book on management of fractures and dislocations in 1825. He classified the fractures at the upper end of femur into

1.Intracapsular fractures

2.Extracapsular fractures and

3.Fractures through Greater trochanter

This classification still holds good. He has also recognized the difference in prognosis of intracapsular and Extracapsular fractures of proximal femur.

In 1860, Buck[16] introduced adhesive plaster strapping for traction in the treatment of fractures.

In 1895, Kocher published a classification of fractures at the proximal femur an improvement over Astley cooper’s classification.

In 1909, Steinmann introduced skeletal traction with the Steinmann pin which forms a part of conservative treatment of fractures of proximal femur.

In 1924, Hamilton Russell[18] introduced a new method of skin traction which became one of the standard methods of conservative treatment of trochanteric fractures. The patients were comfortable and nursing care becomes more easier by this method.

Before 1930, treatment of trochanteric fractures was mainly conservative, i.e. Russell's traction, skeletal traction and well leg traction. From antiquity, the general approach to these fractures consisted of various methods of closed reduction and immobilisation.

Although, Von Langenbeck first reported an open reduction and internal fixation of a fractured hip in 1878, it was only Smith Peterson's refinement of the surgical approach and introduction of the Triflanged nail some 40 years later that operative treatment became a practical alternative. The problems and disadvantages of fixation by wires, threaded wires pins and screw apparatus rapidly forced it into the discard. Additions, deletions and modifications to this armamentarium followed clinical trials in an attempt to correct evident shortcomings in fixation. Smith – Peterson nail has complications like inability to maintain reduction, implant backout, joint penetration through the femoral head.

In order to secure lateral shaft fixation in 1937, Thornton devised a plate attachment for the S.P.Triflanged nail so that trochanteric fractures could be suitably fixed.

In 1941, Jewett[49] developed a welded, single piece, angled nail. The Jewett nail with a few minor structural changes has proven acceptable. All these designs does not permit fracture impaction.

In the same year, Austin Moore[50] designed his ‘Blade plate’ for trochanteric fractures but its use was short lived for this fracture atleast, because of the superiority of other nails. In 1947, McLaughlin engineered a variable angle nail plate, the advantage of which was the ease of adaptation of the plate to the femoral shaft after the nail has been driven in.

In 1949, Boyd and Griffin[13] first classified the type of Intertrochanteric fractures. In the same year, Merwyn and Evans classified intertrochanteric fractures as stable and unstable types.

In 1955, Schumpelich and Jantzen described the use of a Sliding Screw, the design of which they attributed to Ernst Pohl. Callender modified the device further and it was used by Harrington and Johnson in a series of unstable intertrochanteric fractures. Massie introduced a 150 ° sideplate with a telescoping triflanged nail. They provide impaction at the fracture site and reported 33% rate of osteonecrosis.

In 1964, Clawson[51,52] reported on the treatment of trochanteric fractures using a Sliding Screw and plate. The device was developed independently by the Richards' manufacturing company. Clawson made several further modifications and in its current form the device is known as Richards' Compression Hip Screw. In recent years, the Sliding Hip Compression Screw system (Richards, Zimmer, etc.) has become a widely used method of internal fixation for trochanteric fractures.

The sliding hip screw[53] has advantages of large diameter lag screw for better purchase in osteoporotic bone and less trauma than nail insertion. Impaction provided bone on bone contact which favours fracture union. Sliding decreases moment arm and stress on the implant prevent implant failure. Moreover it has a decreased risk of screw cut out by eliminating the sharp edges in the triflanged nail.

In order to make the plate to slide axially along the shaft Egger modified the round holes with slotted holes in the plate assembly of the sliding hip screw.

In 1990, Medoff plate[56,57] (biaxial sliding hip screw) has coupled pair of sliding components on the femoral side plate that enable the fracture to impact parallel to the longitudinal axis of the femur better stabilization with low fixation failure.

In 1967, Dimon and Hughston[58] emphasized that the trochanteric fractures should be classified functionally rather anatomically as the prognosis mainly depends on the stability. They advocated primary medial displacement osteotomy [PMDO] in which the distal fragment is displaced medially under the head neck fragment and the spike of proximal fragment is inserted into the distal fragment and fixed with sliding nip screw device. It has disadvantages of limb shortening, abductor weakness, increased stress on the implant impairing patient ability to regain full ambulatory ability.

In 1970, Augusto Sarmiento[59] emphasized that improper reduction of medial cortex results in reduction in varus with implant failure. Osteotomy gives maximum stability by changing the angle of inclination of the fracture to a less vertical degree and introduces a valgus attitude to the proximal femur. Sarmiento also emphasized that fractures in which medial comminution is so extensive, even osteotomy will not create enough bony contact to ensure stability.

In 1974, Ender[28,30] introduced condylocephalic nailing under C-arm imaging . They are subjected to less bending movements as they are positioned close to the mechanical axis. They have disadvantages like rotational deformity, supracondylar femur fracture, proximal migration of the nail through the femoral head and backout of nail with resultant knee pain and stiffness.

In 1986, Reconstruction nails were developed and commercialized as Russell-Taylor reconstruction nails. They are indicated for ipsilateral fracture of femoral neck with shaft.

In 1990, the Gamma nail[37,38,39,40,41] was introduced for reverse oblique fractures and those with subtrochanteric extension. The intramedullary nail function as a load sharing device with a short lever arm and controlled fracture impaction, less soft tissue dissection and operating time. They have increased risk of femoral shaft fracture at the nail tip.

Proximal femoral nail[1,42,44] was designed in 1997 to overcome implant related complications and facilitate the operative treatment of unstable peritrochanteric fractures. Huber Sm, Heining Sm, Euler E studied the biomechanics of Proximal Femoral Nail and showed a significant reduction of distal stress and an increased stability compared with the Gamma Nail.

In 1999, Simmermacher[61] Rk, Bosch and A.Herrera in their respective studies on Proximal Femoral Nail showed a relatively low percentage of complications and low incidence of implant failure as compared to Gamma nail.

In 2002, Sadowski[63] and Saudan shows in their stuidy, less operative time, less need for blood transfusion and shorter hospitalization in patients who were treated with intramedullary nail when compared to 95° blade plate. The incidence of implant failure and nonunion was 7 out of 19 patients managed with 95° blade plate. This favours its use in unstable fractures.

In 2003, Christian Boldin[55] et al. in his study concluded that proximal Femoral Nail can be applied with a smaller incision with minimal tissue handling for unstable trochanteric fractures.

In 2008, Msg Ballal emphasized that stable reduction and fixation with properly positioned adequate length nail is necessary to avoid fixation failure and revision surgery.

In the same year, Si Yong Park et al. concluded that lesser trochanteric fracture fragment and posteromedial comminution played vital role in the stability after PFN fixation. This is due to toggling of the lag screw and excessive sliding leading to failure.

PROXIMAL FEMORAL NAIL

In 1998, PFN[1,44,54] was introduced in Czechoslovakia by Synthes company which has the biomechanical advantage of all intramedullary devices and considered to be as second generation nail. It is more suitable for treatment of unstable intertrochanteric fractures. It is a closed section cephalomedullary nail with 2 proximal screws that extend into the femoral head and 2 distal locking screws.

The proximal 8cm of PFN diameter is expanded to give additional strength. The nail is having 15mm proximal diameter. There is 6° mediolateral valgus angle for insertion of nail through the greater trochanter and to prevents varus collapse of fracture when there is medial communition. Proximally it has two holes, the distal one for insertion of 8mm lag screw and the proximal one is for 6.4mm derotation screw which helps to prevent the rotation. Both screws are self tapping and partially threaded to allow for sliding compression. The distal diameter is tapered to 9-12mm, which also has groove to prevent stress concentration at the end of the nail and avoids fracture of the shaft distal to the nail. The distally the nail has two holes for insertion of 4.9mm locking screws of which one is static and the other one is dynamic which allows dynamization of 5mm. Distal screws are of 4.9mm fully threaded self tapping locking bolts.

Length	Standard PFN : 250 mm. Long PFN : 340, 380, 420 mm
Diameter	9, 10, 11, 12 mm
Neck shaft angle	130, 135 degrees

The advantage of short nail over long ones are avoidance of mismatch between anterior bowing of femur and longer nails and the relatively reliable targeting of distal locking screws through a proximally attached insertion guide.

PFN has all advantages of an intramedullary device

- Because of its central location[42,44], it provides more efficient load transfer.
- Possibility of insertion through closed technique.
- Decreased blood loss.
- Decreased infection rate
- Minimal soft tissue dissection and wound complications.

In addition it has several other favourable characteristics

Shorter lever arm[54,55] decreases bending stress on the implant and prevents implant failure.

- Controlled impaction is possible at the fracture site because of its sliding mechanism.
- Intramedullary location[73,74] limits the amount of sliding and so minimizes limb shortening and deformity compared with DHS.
- The presence of additional antirotation[1] screw and sliding capacity decrease the overload on the femoral head and increases rotational stability.
- Since it can withstand higher static and cyclical loading, it temporarily compensates for the function of medial column.
- It allows length and rotational control even when lesser trochanter is not intact.
- In case of fracture lateral wall of proximal femur it prevents auto medialisation[67,68] of the shaft.

The main advantages of PFN over Gamma nail[71,72,73] are,

- The presence of two proximal screws provides better rotational control of the proximal fragment.
- Since the two proximal screws are small in diameter, it is not necessary for the nail to be too stout unlike Gamma nail and hence theoretically induces less comminution of proximal segment and less disruption of abductor insertion.
- Lesser incidence of anterior thigh pain[66] and fracture of the femoral shaft compared to Gamma nail.

The main advantages of PFN over DHS[70] are,

- PFN fixation require small incision, less tissue handling, decreased blood loss, decreased probability of infection and increased mechanical stability.
- Allows early weight bearing.
- It can be used in elderly osteoporotic bones.
- PFN act as a buttress to prevent medialisation[67,68] of the shaft (it can be used even in fracture of lateral cortex).
- It also temporarily compensates for the function of medial column.

Disadvantages

- Penetration of the anterior femoral cortex because of mismatch of nail curvature and intact femur.
- Lag screw prominence in the lateral thigh during fracture healing.
- Large hole in the greater trochanter which may compromise abductor function.
- Failure of small superior screw and Z effect[75](seen in unstable fractures due to differing tension and compression forces on two lag screws)

PROXIMAL FEMORAL NAIL

INSTRUMENTATION

INSTRUMENTATION[1]

INSERTION ZIG

It is used for insertion of nail along with conical locking bolt and locking nut. The lugs on the handle must engage the positioning notches at the upper end of nail for insertion. It is used for insertion of proximal neck screws and distal locking screws. The holes in the insertion handle position the locking instruments.

THREADED CONICAL BOLT AND CONICAL NUT

The threaded bolt is screwed by hand into the nail and assembled with insertion handle. Once the lugs of the handle have engaged in notches, firm tightening is achieved with wrench.

DRIVING HEAD

These are used for insertion of nail with a hammer. Driving head is screwed onto the proximal end of the threaded conical bolt for insertion with a hammer.

RAM GUIDE

This is used for insertion and extraction of nail with ram. It is hollow to allow passage of guide rod during insertion. It is connected to conical bolt with the help of connecting piece.

RAM

This is 1300 grams in weight, is slid over the ram guide and used to insert the nail by simply letting it fall a short distance, nail is driven 5 to 10 mm at a time. The ram is also used for removal of nail.

LOCKING INSTRUMENTS

PROTECTION SLEEVES : 11mm/8mm

These are inserted through insertion handle for proximal neck screws and distal locking screws to guide different instruments used for insertion of screws.

DRILL SLEEVES

These drill sleeves accept 6.5mm / 5.0mm drill bits

TROCAR : 8.0mm

This trocar is used with 11mm / 8mm protection sleeves for insertion through soft tissues.

DRILL BITS: 6.5mm, 5.0mm, and 4.0mm.

The 6.5 mm drill bit and 5.0mm drill bit are used to drill holes for 8.0mm femoral neck screw and 6.4 mm anti rotation hip screw respectively. These two drill bits are cannulated for drilling over a guide wire and are marked to know the length of screws to be inserted. The 4.0mm drill bit is used to drill hole for 4.9mm distal locking bolts.

DEPTH GAUZE FOR LOCKING BOLTS

This depth gauze measures up to 115mm. It has a long neck allowing measuring for locking bolts through distal locking holes in insertion handle

HEXAGONAL SCREW DRIVER

This large hexagonal screw driver is used for insertion of 8.0mm femoral neck screw, 6.4mm anti rotational hip screw and 4.9mm distal locking bolts.

MATERIALS AND METHODS

In our institution we have selected 24 cases of unstable intertrochanteric fractures for this prospective study. All cases enrolled were managed with proximal femoral nail. Of them, 15 were male and 9 were female patients. The age group varied from a minimum of 27 years to a maximum of 75 years with an average of 52.45 years. The duration of the study was from May2010 to September 2012. The mean follow up was 8.58 months. Right hip was involved in 11 patients and left hip was involved in 13 patients.

Inclusion criteria:

- All trochanteric fracture classified as unstable by AO classification
- Age more than 25 years.

Exclusion criteria:

- Less than 25 yrs.
- Malunited fracture
- Open fractures
- Pathological fractures of any other cause than osteoporosis
- Previous wound or bone infections.

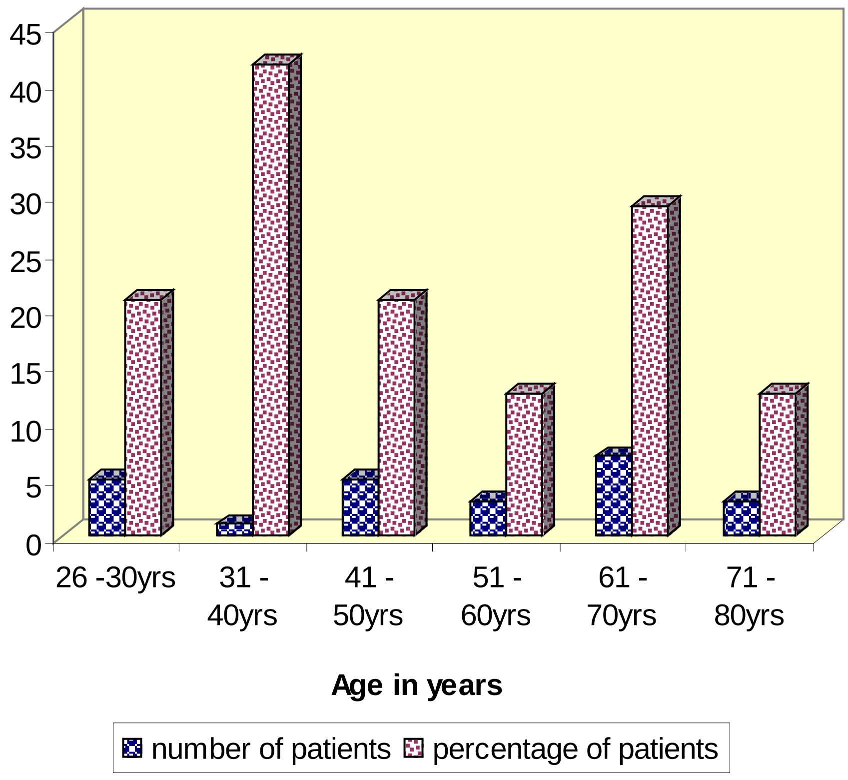
- Neurological and psychiatric disorders that preclude reliable assessment.
- Increased femoral bow.
- Medical co morbidities precluding the patient for internal fixation.

These cases were studied on the basis of mechanism of injury, classification and treatment with proximal femoral nail and their surgical and functional outcome with or without residual complication.

OBSERVATIONS AND RESULTS

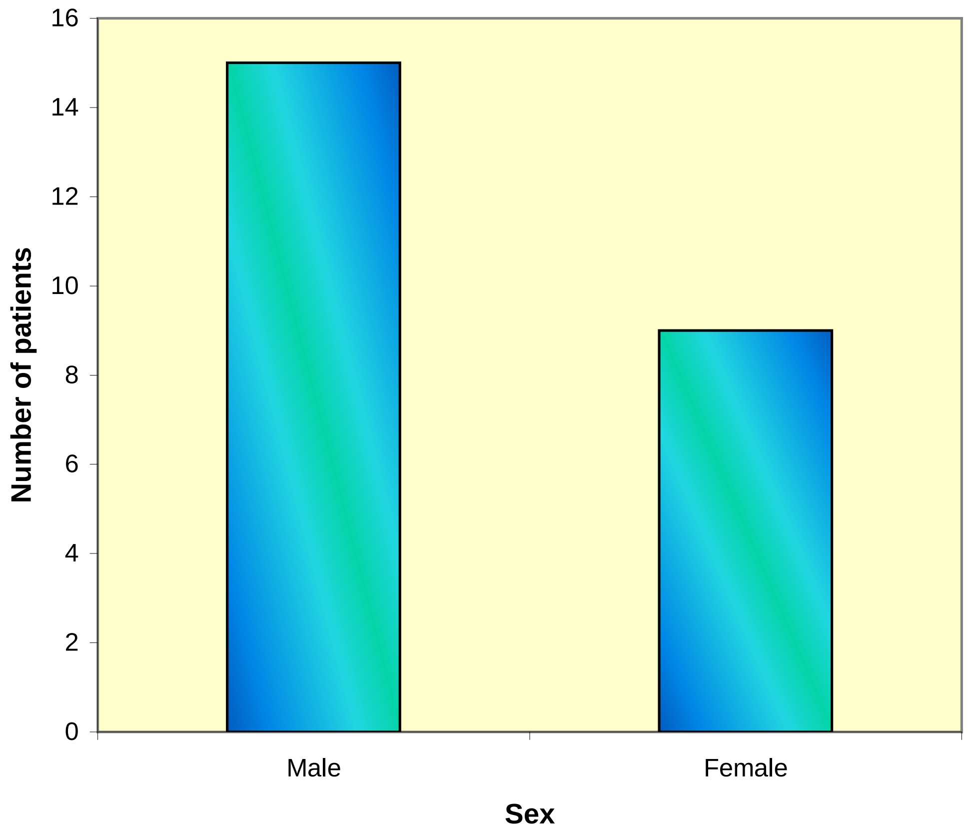
AGE INCIDENCE[80]

AGE GROUP (in years)	Number of patients	Percentage of patients
26 - 30	5	20.8
31 - 40	1	4.16
41 - 50	5	20.8
51 - 60	3	12.5
61 - 70	7	29.1
71 - 80	3	12.5
Average age incidence = 52.45 years		



SEX INCIDENCE[80]

SEX	Number of patients	Percentage of patients
Male	15	62.5
Female	9	37.5



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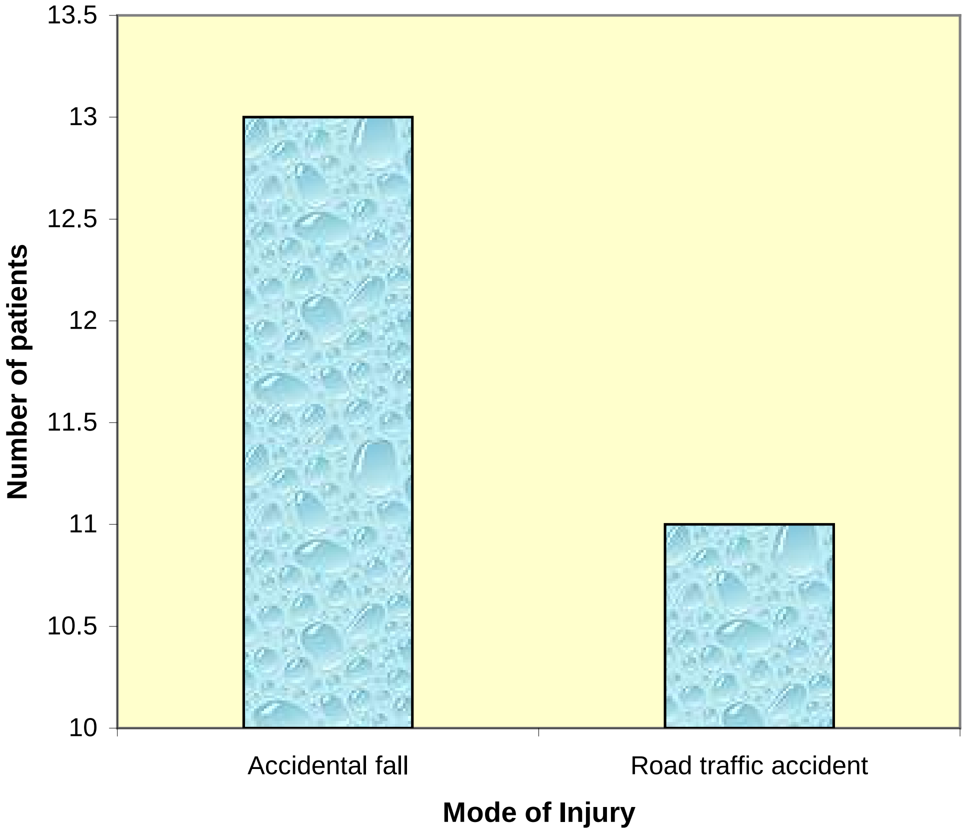
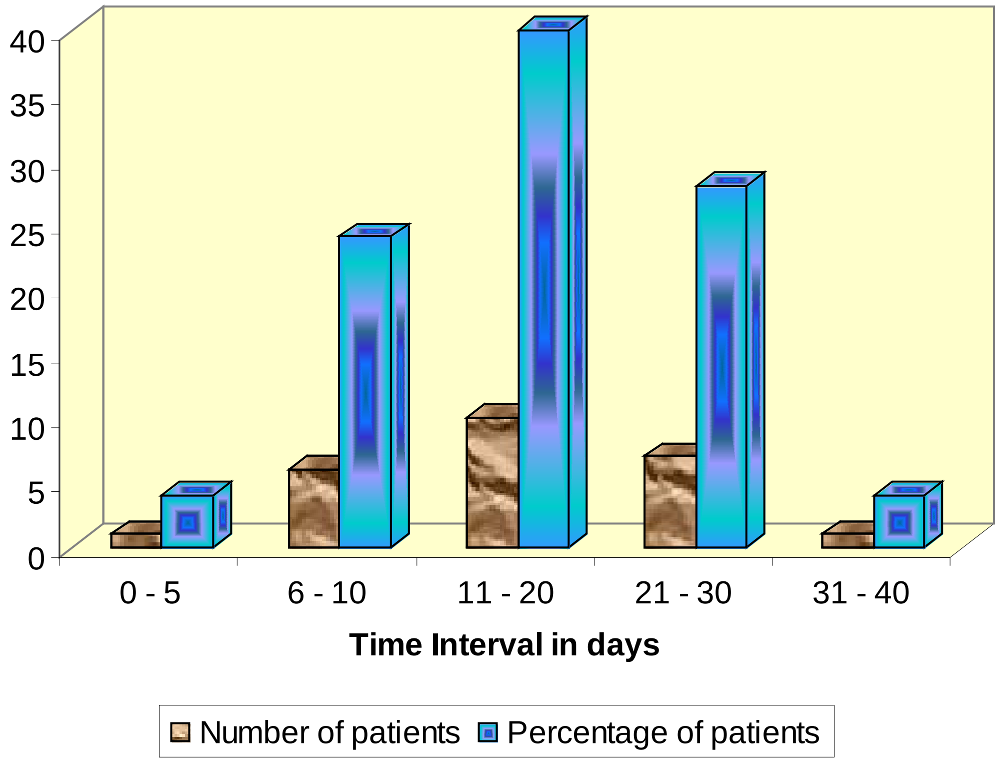
MODE OF INJURY

Mode of injury	Number of patients.	Percentage of patients
Accidental fall	13	54.16
Road traffic accident	11	45.83



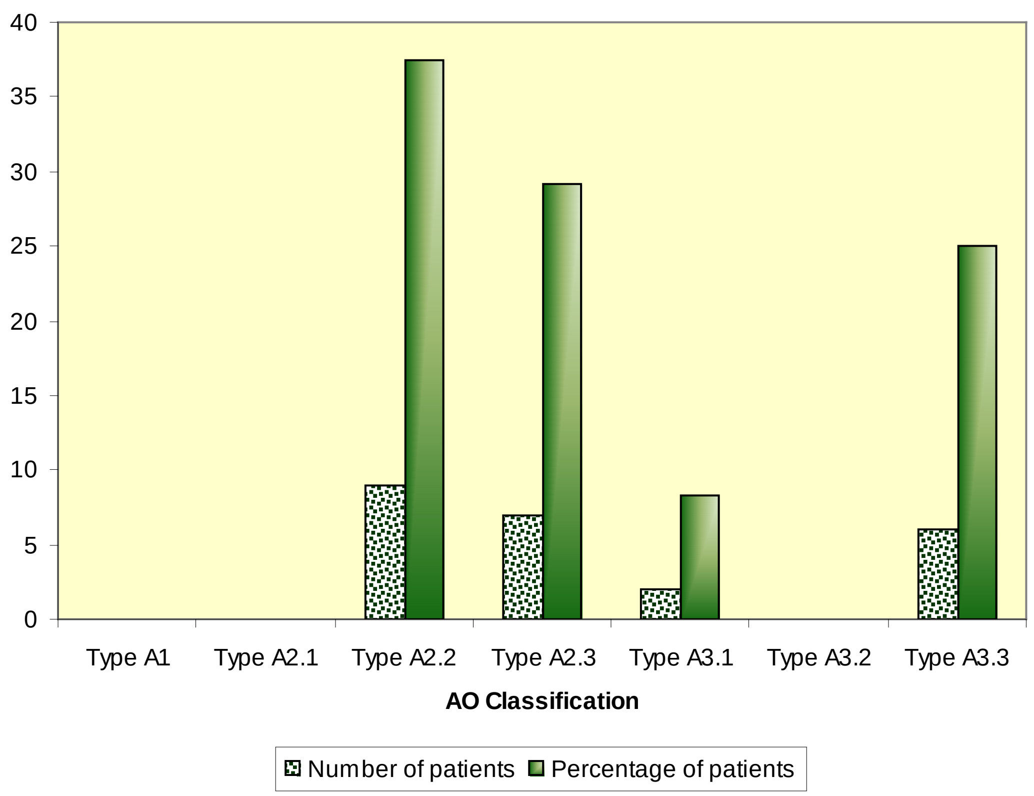
TIME INTERVAL BETWEEN INJURY AND SURGERY

Time interval in days	Number of patients	Percentage of patients
0 - 5	1	4
6 - 10	6	24
11 - 20	10	40
21 - 30	7	28
31 - 40	1	4
Average time interval between injury and procedure = 17.28 days		



CLASSIFICATION[17]

AO CLASSIFICATION	Number of patients	Percentage of patients
Type A1	-	-
Type A2.1	-	-
Type A2.2	9	37.5
Type A2.3	7	29.16
Type A3.1	2	8.33
Type A3.2	-	-
Type A3.3	6	25



TYPES OF PROXIMAL FEMORAL NAIL USED

Proximal femoral nail	Number of patients	Percentage of patients
Long PFN 135 degree	6	25
Short PFN 135 degree	13	54.16
Short PFN 130 degree	5	20.83

EMERGENCY MANAGEMENT IN CASUALTY

- Emergency management of all life threatening conditions was carried out in casualty with respect to –Airway, Breathing and Circulation, IV fluids
- Monitoring of vital parameters
- Blood transfusion as required.
- Management of associated injuries to vital organs like chest, abdomen, head injury etc..
- Oral and Parenteral NSAIDs used to relieve pain.
- Immobilization of affected extremity with skin traction and if surgery is delayed more than 5 days, then skeletal traction in a Bohler Braun splint is applied.

PRE –OPERATIVE MANAGEMENT

All the routine investigations were done as follows,

- Blood sugar level
- Serum urea, creatinine
- Haemoglobin level
- Bleeding time and clotting time
- Urine : sugar, acetone
- Serum electrolytes
- Blood grouping and Rh typing
- HIV ELISA
- Chest X-ray
- ECG
- Echocardiography as per cardiologist opinion if needed.

Specific investigations of all associated medical illness were carried out. Pre operative anaesthetic & physician fitness obtained. Pre operative Parenteral antibiotics[76] administered 1hr before surgery. Skin preparation done morning on the day of surgery.

In our study none of the patients had associated fractures. 1 Patient had diabetic mellitus, 3 patients had systemic hypertension, 1 patient had seizure disorder, 2 patients had cardiac problems and one patient is suffering from COPD.

SURGICAL TECHNIQUE[81]

POSITIONING

The patient is positioned supine on the traction table. The ipsilateral arm is placed in arm sling. The trunk is angled 15 degree towards the unaffected side. The unaffected limb is flexed , abducted and externally rotated for providing enough space for positioning of the image intensifier. The affected lower limb is held in traction and adduction in the foot piece. Reduction is achieved by traction(disengaging fracture fragments) and internally rotating the limb while maintaining traction and confirmed with image intensifier.

APPROACH[81]

A 3cm incision is made proximal to the tip of greater trochanter slightly bent dorsally. skin, subcutaneous tissue and deep fascia incised. Gluteus maximus split by blunt dissection. The tip of trochanter is felt with finger.

ENTRY POINT

Reduction of the fracture is essential before making the entry point. After confirming the anatomical reduction , entry point is made with bone awl over the tip of greater trochanter. If the reduction is not anatomical, we used to manipulate the fragments by percutaneously passing the Steinmann pin and temporarily holding the reduction with ‘k’ wires driven along the anterior cortex such a way that it should not interfere with the path of nail. By confirming the position in AP and lateral view, the awl is driven just proximal to the level of lesser trochanter.

GUIDE WIRE INSERTION AND REAMING

A 3.2mm guide wire is inserted and driven into the distal fragment. Proximal reaming done with 15mm cannulated awl upto 7 cm distally to accommodate the proximal portion of the nail. Distal reaming done 1mm more than the desired diameter of the nail.

NAIL INSERTION

The nail closely matching to the neck shaft angle of the unaffected hip is assembled in the zig. The nail is inserted over the zig by hand by gentle twisting movements. The PFN is inserted to the appropriate depth to allow placement of two screws within the femoral neck. The guide wire is removed.

PROXIMAL TARGETING

The nail with the zig is checked for alignment of proximal and distal targeting guide to the corresponding holes in the nail before insertion . Through a stab incision drill sleeves are inserted into the proximal targeting guide upto the lateral cortex with the help of trocar. Under C- arm control the guide pins for the lag screw and derotation screw are driven in through guide pin sleeves upto 5 mm from the articular surface of the femoral head. The lag screw and derotation screw of appropriate length is inserted after drilling with cannulated drill bit. The derotation screw should be 10 to 15mm smaller than the lag screw to avoid ‘Z’ effect. It is ideal to insert the lag screw along the inferior aspect of the neck particularly if there is medial comminution.

DISTAL TARGETING

Distal targeting is done with distal targeting guide and drill sleeves using 4.0mm drill bit. In case of long nail, distal locking is done through free hand technique.

OPERATIVE PROCEDURE

1. Positioning of the Patient

2. Incision

3. Entry point with bone awl - AP

4. Entry point with bone awl - LAT.

5. Guidewire - AP

6. Guidewire - LAT.

OPERATIVE PROCEDURE

7. Insertion of nail and guidepin

8. Guidepin - AP view

9. Guidepin - LAT. view

10. Nail with proximal screws - AP

11. Nail with proximal screws - LAT.

12. Distal locking - LAT. view

12. Distal locking - AP view

OPERATING TIME

Operating time (in min.)	Number of patients	Percentage of patients
<45	5	20.83
45 - 60	7	29.16
61 – 75	7	29.16
76 - 90	5	20.83
Mean duration of surgery = 58 minutes		

INTRA OPERATIVE COMPLICATIONS

Complication	Number of cases
Fracture displacement by nail insertion	3
Failure to get anatomical reduction	1
Difficulty to put derotation screw	3
Breakage of guide wire	1
Breakage of drill bit	0
Varus angulation	3

POST OPERATIVE MANAGEMENT

- Parenteral third generation cephalosporin and aminoglycosides were given. Oral antibiotics started from fifth post op day and continued till suture removal.

- Parenteral NSAIDS given for the first two days and changed to oral thereafter.
- Drain was removed after 48 hrs.
- Static and dynamic quadriceps exercises from day 2 were begun.
- Non weight bearing walking was started from the 2^{nd} postoperative day as tolerated by the patient.
- Early hip and knee assisted ROM were started from third day.
- Suture removal after 12 days.
- Patient discharged 5 to 7 days after surgery after giving appropriate physiotherapy instructions.
- Rehabilitation[82]: partial weight bearing was started 2 to 4 weeks post operatively. Full weight bearing was allowed after radiological and clinical signs of union.

FOLLOWUP

- Patients were evaluated clinically and radiologically every 4 weeks for 2months and every 6 weeks thereafter until signs of radiological union appears.
- Clinical union was observed as the absence of pain and tenderness with full weight bearing.

CLINICAL ASSESSMENT INCLUDES,

1. Gait
2. Pain
3. Deformity
4. Shortening
5. Range of movements
6. Ability to sit cross legged
7. Ability to squat.
8. Return to pre-injury occupation.

RADIOLOGICAL ASSESSMENT INCLUDES,

1. Signs of union
2. Varus collapse
3. Amount of lateral slide
4. Screw cut out
5. ‘Z’ effect
6. Implant failure and loss of fixation.

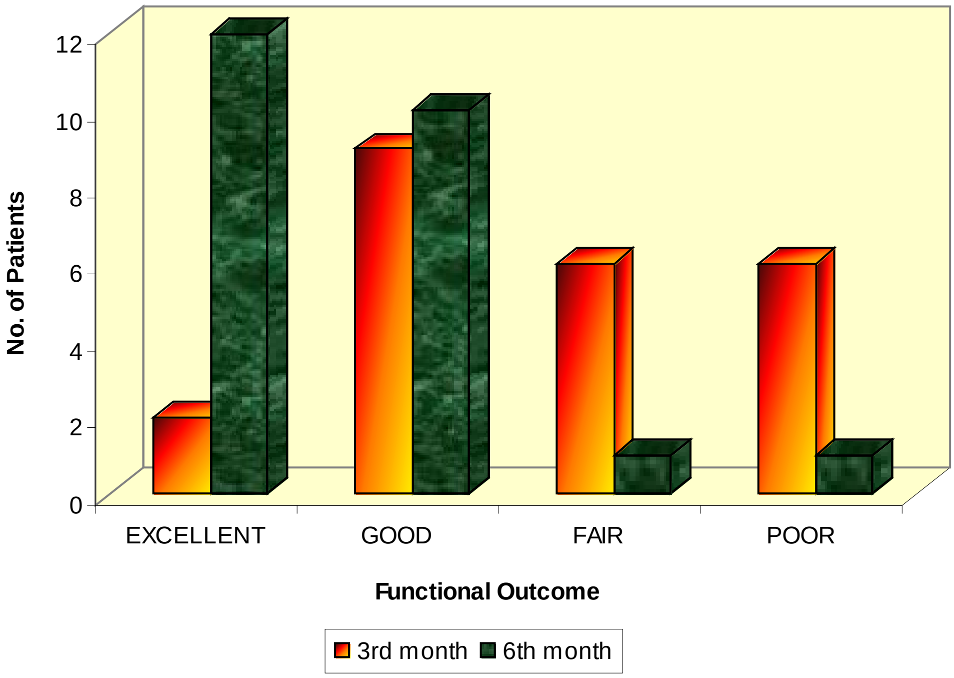
- The patients were evaluated with Modified Harris hip score[78,79] at 3rd month and 6th month and Patients were categorized according to the scores they attained as follows:

- **Excellent: 100 - 90**
- **Good : 89 - 80**
- **Fair : 79 - 70**
- **Poor : < 70**

- Among 24 patients the average duration of followup was estimated to be 8.58month.

HARRIS HIP SCORE[78,79,84]

Functional outcome	**3rd month**		**6th month**	
	Number of patients	**Percentage of patients**	**Number of patients**	**Percentage of patients**
Excellent	2	8.33	12	50
Good	9	37.5	10	41.66
Fair	6	25	1	4.16
Poor	6	25	1	4.16

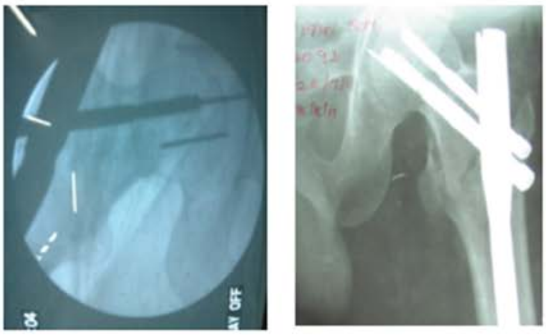


POST OPERATIVE COMPLICATIONS

S. No.	Complications	Number of patients
1.	Shortening	9
2.	Superficial infection	1
3.	Deep infection	1
4.	Varus collapse	6
5.	Lateral slide of proximal screws	6
6.	Non union	0
7.	‘Z’ effect[84]	1
8.	Implant failure	1
9.	Mortality	0

COMPLICATIONS

1.INTRAOPERATIVE DRILL BIT BREAKAGE



2. REVERSE 'Z' EFFECT

3.INFECTION WITH 'Z' EFFECT

4.Implant failure with malunion

CASE – 1 Siva 45 M IP: 42737

Pre op xray

Immediate post op xray

4th week

16th week

CASE - 2 Pavayee 70F IP: 11624

Pre op – AP   Lateral   Immediate post op

6th week   12th week   16th week   9th month AP

9th month Lateral

CASE - 3 Ponnammal 70F IP : 30888

Pre op

Immediate post op

4 month followup

CASE - 4 Maragatham 75 F IP : 52469

Pre op

post op – AP

Lateral

4th week

10th week

14th week

14 month followup
Screw breakage with varus collapse, shortening

CASE -7 Kulandaisamy 50M IP: 53180

Pre op

Immediate postop

4th week

10th week

10th month

Superficial infection

CASE - 6 Alamelu 70F IP : 7044

Pre op AP

Immediate Post op AP

Lateral

4th Month

8th Month AP

8th Month Lateral

CASE - 5 Palaniyappan 65 M IP: 13249

Preoperative AP

Preoperative Lateral

Immediate post op AP

Lateral

6th week

14th week- AP

Lateral

CASE - 8 Abdulkadar 48M IP : 34342

Preoperative AP

Preoperative Lateral

Immediate post op AP

Immediate post op Lateral

3rd Month

5th Month

CASE - 9 Ponnusamy 35M IP: 54013

Pre op AP

Immediate post op

22 weeks

DISCUSSION

The successful treatment of intertrochanteric fractures depends on many factors[86]: the age of the patient, the patient's general health, the time from fracture to treatment, concurrent medical treatment and the stability of fixation[89]. The appropriate method and the ideal implant used for these fractures are still debated with proponents of the various approaches each claiming advantages over others. Many internal fixation devices have been recommended for the treatment of these fractures, including extramedullary and intramedullary implants.

The dynamic hip screw remains the implant of choice because of its favourable results and low rate of non-union and failure. It provides controlled compression at the fracture site. The use of DHS has been supported by its biomechanical properties which have been assumed to improve the healing of fractures[90]. DHS requires a relatively larger exposure, more tissue handling and anatomical reduction, all of which increase the morbidity, the probability of infection and significant blood loss, the possibility of varus collapse and the inability of the implant to survive until fracture union. The side plate and screws weaken the bone mechanically. The common causes of fixation failure are unstable trochanteric fractures, osteoporosis, lack of anatomical reduction, failure of the fixation device and incorrect placement of the lag screw in femoral head[91,92].

Control of axial telescoping and rotational stability are essential in unstable proximal femoral fractures. An intramedullary implant inserted in a minimally invasive manner is better tolerated in the elderly patients[93]. The cephalomedullary nails with a trochanteric entry point have gained popularity in recent years[94]. They have been shown to be biomechanically[64] stronger than extramedullary implants. The Gamma nail is associated with specific complications, among which is anterior thigh pain[95] and fracture of the femoral shaft[3] are most common.

The PFN system[3], developed by AO/ASIF, has some major biomechanical innovations to overcome the previously mentioned limitations of the Gamma nail:

- By addition of the 6.5 mm anti-rotation hip screw to reduce the incidence of implant cut-out and the rotation of the cervico-cephalic fragment. In this respect, it should be borne in mind that the lag screw must be adjusted to the calcar, taking into account the need to place the antirotational hip screw.

- Smaller diameter and fluting of the tip[96] of the nail, specially designed to reduce stress forces below the implant and therefore the incidence of low-energy fracture at the tip.
- Greater implant length, smaller valgus angle and setting of this angle at a higher level (11 cm from the proximal end).
- More proximal positioning of the distal locking, to avoid abrupt changes in stiffness of the construct which prevents failure at the distal locking site

The PFN nail has been shown to prevent the fractures of the femoral shaft by having a smaller distal shaft diameter[96] which reduces stress concentration at the tip.

Intramedullary implants for internal fixation of the proximal femur withstand higher static and a several-fold higher cyclical loading than DHS types of implants. As a result, the fracture heals even without the primary restoration of the medial support. The implant temporarily compensates for the function of the medial column[97].

In A1 and A2 fractures axial loading leads to fracture impaction, whereas in A3 fractures such impaction does not occur, and medial displacement of the distal fragment of the fracture is common due to the instability. Due to its position close to the weight-bearing axis the stress generated on the intramedullary implants is negligible. The PFN implant also acts as a buttress in preventing the medialisation[67] of the shaft.

Biomechanically, compared to a laterally fixed side plate[60], the intramedullary nail decreases the bending force on the hip joint by 25 to 30% . This has advantage in elderly age group to make them weight bear earlier. The entry portal of the PFN through the trochanter limits the surgical insult to the tendinous hip abductor musculature only, unlike those nails which require entry through the pyriformis fossa. Compared to Gamma nail, the additional anti- rotation screw[55,64,73] placed in the femoral neck avoid rotation of the cervicocephalic fragments during weight bearing. The stabilising and the compression screws of the PFN adequately compress the fracture, leaving between them a bone block[98] for further revision should the need arise.

In our study of 24 patients with unstable intertrochanteric fracture, the average age incidence was 54.64 years. This is in contrast to higher age group as reported by western literatures. Our study results are comparable with those of RC Gupta et al., Mohanty SP et al.[88] Majority of cases occurred in older individuals as the average life expectancy of an Indian is 10 years less than western standards and malnutrition and osteoporosis go hand in hand.

Authors	Average age
Karl Lunsp et al.[47]	81.0
Eckriffiner et al.[62]	75.1
Boyd and Griffin[13]	69.7
R C Gupta[86]	51.2
Richard Kyle[87]	72
Mohanty S P[88]	61.7
G.S. Kulkarni[86]	62

In the present study male: female was 5 : 3. There was a male sex preponderance seen in our study. This is in contrast to female preponderance as observed by various other authors[67,82,3] as the Indian males are being more active & mobile than females. The mechanism of injury was accidental fall in 13 patients and road traffic accident in 11 patients. None of the patient had any associated injuries. The mean duration between the injury and procedure was 17.28 days. The average operating time was estimated as 58 minutes. In the initial cases our operating time was on the higher range, with experience the operating time reduced.

Average Operating Time	Dousa et al[3]	Pavelka.T et al [97]	Pajarinan.J et al [67,82]	Our series
	61 min	56 min	55 min	58 min

Intraoperatively, in one patient we had difficulty in achieving reduction by closed means, so we achieved reduction by opening the fracture site.

We used short nail in 18 cases and long nail in 6 cases .We used longer nail[98] for unstable reverse oblique and fractures with subtrochanteric extension to minimize periprosthetic fracture from stress raiser effect from the tip of the nail. Mismatch between nail curvature and femoral bow will result in impingement of the tip of the nail over the anterior cortex. We have no cases of femoral shaft fractures. Egol [98,100]and colleagues reported that the average anterior femoral curvature was 120cm (+/-36cm). Radius of nail curvature should be ranged 186 – 300 cm.

We had guide pin breakage in one case while drilling for lag screw and the guide pin[99] can't be retrieved. Since the broken guide pin is within the femoral head, it does not interfere with the hip movements. So we have to avoid the guide pin crossing the hip joint[99] because if the guide pin breaks it is difficult to retrieve from the acetabulum.

We have encountered difficulty while drilling for the lag screw, the drill was scraping against the hole edge in the nail. This is solved by transient release of traction. The sleeve must be placed in such a way that it should hitch the outer cortex before inserting the guide pin. Otherwise, there is chance of toggling and bending of the guide pin at the sleeve bone interface. We encountered difficulty in passing derotation screw in 3 cases. In these cases the guide pin is going along the superior aspect of the neck. It was dealt by passing 130degree nail instead of 135degree.

We have encountered distraction at the fracture site on passing the nail in 4 cases, in these cases the fracture is reduced and temporarily stabilized with a 2mm 'K' wire passed along the anterior cortex so as not to interfere with the passage of nail.

In 3 cases we had encountered with varus reduction[81]. This can be prevented by increasing the traction while advancing the nail, removing the guide pin from the femoral head and abducting the lower limb.

In our study, 9 of our patients had abductor lurch which gradually decrease with time. In one cadaveric study 17mm entry for gamma nail over the greater trochanter would remove an average of 27% of gluteus medius insertion[100]. Even though the entry point for

PFN is 15mm it still have a chance of abductor compromise. The varus collapse and shortening also contribute to the lurch seen in these patients.

Initially we used to do static locking for fractures with severe comminution. Now we prefer to do dyanamic locking for all cases irrespective of severity of comminution. In a study by Hardy et al.[101], he noted that increased stress at the tip of the nail may lead to cortical hypertrophy with thigh pain and fracture around the distal locking screws. He stated that use of two static locking screws is correlated with a high rate of cortical hypertrophy, while the use of dynamic locked nail has significantly reduced this complication.

We had shortening of 3 cm in one case, 2cm in two cases, 1cm in five cases, <1cm in one case. In DHS, excessive sliding of lag screw will result in limb shortening. In PFN, the amount of shortening is comparatively less as there is controlled fracture impaction[62,64,72,73] (fracture can settle only until the proximal fragment abuts against the nail). The shortening is managed with sole raise in 3 cases.

All of our patients could partial weight bear by the end of 2 weeks. None of the patient was using walking aid beyond 3months. In a study Pajarinen et al.[67] showed that the use of PFN have a positive effect on the speed at which walking is restored.

In our series, 6 patients had varus collapse with an average of 10 degree. This is attributed to excessive sliding and collapse secondary to fracture comminution and premature weight bearing. There was lateral slide of lag screw in 9 cases. Lateral slide[62,64,72,73] occurs more often in PFN than Gamma nail due to restricted sliding mechanism in gamma nail from rigid femoral neck screw nail assembly. This is also a factor for increased incidence of screw cut out seen in gamma nail which is rare in PFN. Herera et al.[64] in a comparative study of 250 pertrochanteric fractures treated with the simple GN or the PFN system (125fractures in each group) reported a statistically significant difference in the incidence of neck screw cut-out (4%) and fracture below the nail (3.2%) in the GN group, whereas in the PFN group there was a higher incidence of secondary varus (7.2%) and collapse at the fracture site due to screw migration (8%).

There were 3 cases with failure of derotation screw at the junction of threaded portion and the screw shaft. Among the three, one patient had varus reduction, one had distraction at the fracture site, one patient had associated nail breakage with fracture in varus malunion from premature weight bearing. The patient with implant failure attended the OPD after around 5 months. Eventhough the patient had implant failure with malunion, the patient had a good functional outcome.

The screw breakage is secondary due to increased stress from the forementioned contributing factors. Domingo et al.[42] prospectively evaluated 295 patients in whom the majority (59%) had an 31A2 intertrochanteric fracture and reported technical complications in 12% of the patients during the operation, 27% in the immediate postoperative period and late complications in 4%. Banan et al.[54] reported a higher technical failure rate (8.7%) due to cut-out, 1 case of implant failure and 2 cases of fracture below the tip of the nail after a second fall, out of 60 patients with exclusively unstable trochanteric fractures.

One case had deep infection with secondary ‘Z’ effect[75,84]. Initially we have done wound debridement and put the patient on Parenteral antibiotics according to the culture sensitivity. The infection had settled and the inward migrated derotation screw is removed. The lag screw is tightened. Patient put on non weight bearing. Werner et al.[75] was the first that introduced the term Z-effect, detected in 5 (7.1%) of 70 cases. The incidence of cut-out of the neck screw in this study was 8.6%. The reverse Z-effect described by Boldin et al.[55] occurred with movement of the hip pin towards the lateral side, which required early removal. The mechanism is similar, but here the hip pin is sliding back, whereas the neck screw remains impacted to the hole of the nail. The Z- effect phenomenon is referred as a characteristic sliding of the proximal screws to opposite directions during the postoperative weight-bearing period. The ‘Z’ effect phenomenon which manifests as collapse of head/neck fragment resulting in protrussio of the superior lag screw and migration of the inferior lag screw lateral to the nail. Although medial cortical comminution and varus positioning contribute to the ‘Z’ effect, the exact etiology of differential screw migration has yet to be determined. The derotation screw must be 10 – 15 mm less than the lar screw. The tip of both screws and the proximal end of the nail must be in the same line.the lag screw should have purchase along the inferior cortex of the neck to minimize ‘Z’ effect.

In a laboratory analysis by Kenneth A.Egol[84], inferior lag screw migration was greatest for specimens with the largest compressive strength difference between the head and neck and increased with increasing number of loading cycles. Screw migration was not observed in specimens with equal head and neck compressive strength. Penetration of the superior lag screw through the head component was seen in specimens with lower head compressive strength, but not in those with higher head compressive strength. The reverse Z-effect was not seen in models where the compressive strength of the neck was greater than that of the head.

In cases where the density and resultant compressive strength of the neck is significantly lower than that of the head, a situation which may be seen with unstable fracture patterns with significant medial cortical comminution, the combination of superior lag screw engagement in the nail, lack of bony purchase in the neck, and toggle of the inferior lag screw from repetitive loading causes the inferior lag screw to migrate laterally. Continued vertical loading and increased varus forces on the superior, locked screw in the head may eventually lead to femoral head penetration. Limitations of the current study include the use of polyurethane foam Sawbones biomechanical testing blocks to simulate the actual femoral neck and head.

The average time for fracture union was 11.12 weeks(range : 8 – 22weeks). In a meta-analysis, Kaplan et al. presented a mean time taken to achieve consolidation of four months, independent of the device used. On the other hand, Bride et al reported that consolidation occurred after an average of six months. According to Crawford et al.[86], the consolidation rate found among patients treated with a cephalomedullary nail was 89%. In the present study, consolidation was observed in all the patients after 5 months. Patients were followed up for an average period of 8.58 months and the results were analyzed by using the harris hip scoring system. Among these patients union occurred in all patients with no non-union. Malunion occurs in one case with implant failure. The mean harris hip score was 88.75 at 6th month. The score was excellent in 12 patients, good in 10 patients, fair in 1 patient and poor in 1patient. The results are almost similar to other international studies done in the same method.

Schipper et al.[72] found a mean score of 66.80 (standard deviation = 17.94) with a proximal femoral nail of PFN® type after one year. According to Pajarinen et al.[90], patients who underwent osteosynthesis with a cephalomedullary nail, in unstable trochanteric fractures, presented a significantly faster return to their previous level of walking.

Herrera et al.[62] reported on a study involving 250 patients treated with the PFN and Gamma nail cephalomedullary nails, in which around 50% of the patients had recovered their previous walking capacity, one year after the surgery. In the present study, we assessed the recovery of walking ability over the course of time. The greatest evolution in the quality of walking occurred over the first three months after the operation, such that none of our patients are walking with walking aid.

In short, the PFN has distinct advantages over DHS and it has proved to be a better implant with adequate surgical technique. The requirement and follow up based changes in design of PFN from the pioneer Gamma mail will certainly decrease the complication rates and increases all the postulated advantages of Intramedullary devices used in the treatment of trochanteric fractures.

CONCLUSION

Finally, we conclude that the PFN is a significant advancement in the treatment of unstable trochanteric fractures which has the unique advantages of closed reduction, preservation of fracture hematoma, less tissue damage, early rehabilitation and early return to work. Osteosynthesis using a PFN, used in unstable trochanteric fractures, resulted in low rates of clinical complications, excellent stabilization, few mechanical complications and adequate functional results. Thus the treatment of unstable intertrochanteric fracture with PFN had a more favourable outcome and it is the ideal implant of choice for unstable intertrochanteric fractures at present.

MASTER CHART

S. NO.	NAME	AGE	SEX	I.P. NO.	Date of Admission	Mode of injury	classification (AO)	Side	Associated comorbidites	Interval between injury & surgery (days)	Reduction	Nail size	shortening (cm)	varus collapse (degree)	superior screw breakage	Lurch	Lateral slide	Implant faliure	Infection	Z'effect	Time for union (weeks)	Follow up (mths)	Harris hip score (3rd month)	Harris hip score (6th month)	Results
1	Ponnusamy	55	*M*	54013	02/10/11	RTA	31A3.3	R		26	OR	11x135	3	15	+	+		+			22	8		87	G
2	Muruganandam	30	*M*	39157	03/07/11	RTA	31A2.2	L		15	CR	12x130									10	10	78	89	G
3	Elumalai	75	*M*	20470	29/04/11	AF	31A2.2	L	HT	24	CR	9x130	1			+	+				10	14	75	89	G
4	Abdul Kadar	48	*M*	34342	05/06/11	AF	31A2.2	R	epi-lepsy	16	CR	10x135					+				8	15	90	93	E
5	Madaiyan	37	*M*	30752	15/05/11	RTA	31A2.2	L		9	CR	9x135				+	+				8	9	82	92	E
6	Lakshmanan	55	*M*	36486	17/06/11	AF	31A3.3	L	DM	23	CR	9x130	1			+			+	+	8	6	81	87	G
7	Thirupathy	27	*M*	34722	07/06/11	RTA	31A2.3	R	VSD	20	CR	10x135									10	6	87	92	E

8	Siva	45	*M*	42737	24/07/11	RTA	31A 2.3	L		10	CR	10x135 (long)									16	12	91	99	E
9	Rayappan	50	*M*	43092	26/07/11	AF	31A 2.2	L		11	CR	10x130									12	6	75	79	F
10	Vaithi	70	*M*	51892	20/09/11	AF	31A 2.3	L	COPD	40	CR	11x135	2	12	+	+	+				16	12	46	66	P
11	Maragatham	75	*F*	52467	23/09/11	AF	31A 2.2	R	HT	10	CR	10x135	1	8	+	+					14	14	58	80	G
12	Kulandaisamy	50	*M*	53180	27/09/11	RTA	31A 2.2	R		17	CR	10x130	1			+			+		10	12	69	92	E
13	Kuppayammal	70	*F*	56487	17/10/11	AF	31A 2.3	R		5	CR	10x135									10	5	80	91	E
14	Alamelu	70	*F*	58733	25/10/11	AF	31A 2.2	L	HT	21	CR	11x135				+					10	12	70	83	G
15	Sakhul Ahmed	27	*M*	4277	26/01/12	RTA	31A 3.3	R	C.D.	25	CR	9x135 (long)									12	6	69	93	E
16	Kannupillai	75	*F*	8733	17/02/12	AF	31A 2.3	L		28	CR	10x135									9	5	81	92	E
17	Maheswari	30	*F*	11366	27/02/12	RTA	31A 3.3	L		30	CR	10x135 (long)									12	6	78	87	G

18	Pavayee	70	*F*	11624	28/02/12	AF	31A3.3	R		14	CR	10x135 (long)	<1	5		+	+				16	9	67	92	E
19	Kumar	30	*M*	21728	20/04/12	RTA	31A3.3	R		18	CR	11x135									12	6	78	87	G
20	Saradha	70	*F*	780	05/01/12	AF	31A2.3	L		13	CR	10x135	1	10		+	+				14	6	82	90	E
21	Alamelu	70	*F*	7044	07/02/12	AF	31A2.2	R		20	CR	11x135					+				12	8	70	93	E
22	Palaniyappan	65	*M*	13249	07/03/12	RTA	31A2.3	L		8	CR	12X135									14	8	87	99	E
23	Ponnamal	70	*F*	30888	19/07/12	AF	31A3.1	R		9	CR	9x135 (long)	2	15		+	+				16	5	57	81	G
24	Madhu	42	*M*	7312	09/02/12	RTA	31A3.1	L		11	CR	10x135 (long)									8	6	80	87	G

ABBREVIATIONS FOR MASTER CHART

M	MALE	DM	DIABETES MELLITUS
F	FEMALE	CR	CLOSED REDUCTION
RTA	ROAD TRAFFIC ACCIDENT	OR	OPEN REDUCTION
AF	ACCIDENTIAL FALL	VSD	VENTRICULAR SEPTAL DEFECT
L	LEFT	E	EXCELLENT
R	RIGHT	G	GOOD
C.D.	CARDIAC DISEASE	F	FAIR
+	PRESENT	P	POOR
HT	HYPERTENSION		

PROFORMA

1. Name of the patient :
2. Age / Sex :
3. I.P. no. :
4. Occupation :
5. Address: Phone no. :
6. Date of admission :
7. Interval between injury and admission :
8. Mode of Injury :
9. Side of injury :
10. Associated injuries :
11. Associated medical co morbidities :
12. X – ray pelvis with both Hip and Femur :
13. AO classification :
14. Pre operative traction :
15. Interval between admission and surgery :
16. Type of anaesthetia :
17. Position of the patient :
18. Method of reduction :
19. Type of implant used :

20. Duration of surgery :

21. Intra operative complication :

22. Post operative treatment :

    - Physiotheraphy :

    - Weight bearing :

23. Blood transfusion :

24. Drain removal :

25. Date of discharge :

26. Suture removal :

27. Post operative complication :

28. Clinical assessment during follow up :

29. Fracture union :

30. Harris hip score :

    - 3^{rd} month :

    - 6^{th} month :

HARRIS HIP SCORE:

PAIN:

None or ignores it (44)

Slight, occasional, no compromise in activities (40)

Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin (30)

Moderate pain, tolerable but makes concessions to pain; some limitation of ordinary activity or work; may require occasional pain medicine stronger than aspirin (20)

Marked pain, serious limitation of activities (10)

Totally disabled, crippled, pain in bed, bedridden (0).

LIMP:

None(11)

Slight (8)

Moderate (5)

Severe (0)

SUPPORT:

None (11)

Cane for long walks (7)

Cane most of the time (5)

One crutch (3)

Two canes (2)

Two crutches (0)

Not able to walk (0)

<u>DISTANCE WALKED:</u>

Unlimited (11)

Six blocks (8)

Two or three blocks (5)

Indoors only (2)

Bed and chair (0)

<u>STAIRS</u>:

Normally without using a railing (4)

Normally using a railing (2)

In any manner (1)

Unable to do stairs (0)

<u>PUT ON SHOES AND SOCKS</u>:

With ease (4)

With difficulty (2)

Unable (0)

<u>SITTING</u><u>:</u>

Comfortably in ordinary chair one hour (5)

On a high chair for one-half hour (3)

Unable to sit comfortably in any chair (0)

<u>Enter public transportation </u>(1):

Yes.

No.

Flexion contracture : …… (degrees).

Limb length discrepancy : …… (cm).

Absence of deformity: (All Yes - 4; Less Than 4-0)

Less than 30° fixed flexion contracture: Yes - No

Less than 10° fixed adduction: Yes - No

Less than 10° fixed internal rotation in extension : Yes - No

Limb length discrepancy less than 3.2 cm : Yes - No

<u>RANGE OF MOTION:</u>

Flexion (140°) : ……

Abduction (40°) : ……

Adduction (40°) : ……

External rotation (40°) : ……

Internal rotation (40°) : …

Range of motion score :

211° - 300° (5)

161° - 210° (4)

101° - 160° (3)

61° - 100° (2)

31° - 60° (1)

0° - 30° (0)

Range of Motion Score: ……

Total Harris Hip Score: ……

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